THE

YEAR-BOOK OF FACTS

IN

Science and Art:

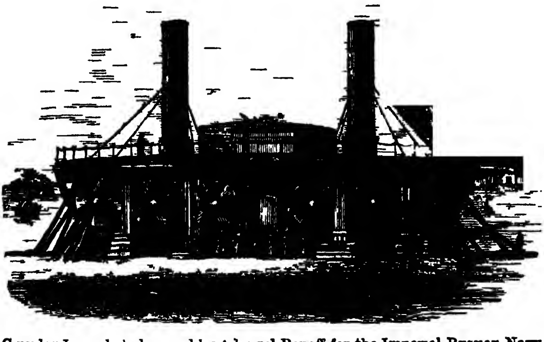
EXHIBITING

THE MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS OF THE PAST YEAR

IN MECHANICS AND THE USEFUL ARTS, GENERAL SCIENCE, ELECTRICITY, CHEMISTRY, ZOOLOGY AND BOTANY, GEOLOGY AND MINERALOGY, METEOROLOGY AND ASTRONOMY

BY JOHN TIMBS,

AUTHOR OF 'CURIOSITIES OF SCIENCE,' 'THINGS NOT GENERALLY KNOWN,' ETC.



Circular Iron-clad, designed by Admiral Popoff for the Imperial Russian Navy. (See p. 11.)

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OCKWOOD & CO., 7 STATIONERS'-HALL COURT.

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From the 'Athenæum,' March 23, 1872.

"'The Year-Book of Facts in Science and Art,' compiled by Mr. John Timbs, is too well known to require any special notice. The volume for 1872 is just published. It contains the usual notices, carefully selected, connected with every branch of science, theoretical and applied, and with most of the technical arts."

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PROFESSOR TYNDALL, F.R.S., ETC.

(See the Portrait.)

This distinguished man of science, the present Professor of Natural Philosophy at the Royal Institution, was born at Leighlin Bridge, county Carlow, Ireland. His name sufficiently indicates that he is of English descent. His father had a ruling taste for religious subjects. He was a great reader of Chillingworth and other protestant writers, and Dr. Tyndall's earliest intellectual culture consisted of exercises on the doctrines of purgatory, infallibility, transubstantiation, and the invocation of saints. Professor Tyndall's father, though poor, was a man of singularly independent mind, and his last words to his son were those of Wolsey to Cromwell: "Be just and fear nothing." Dr. Tyndall was at school from his earliest years till 1839, the first portion of his education being received at a school near his home, where he imbibed a taste for mathematics.

In 1839, when he left school, he became, at the instance of Lieut., now Gen. Wynne, R.E., an assistant in a division of the Ordnance Survey, where he made himself a good trigonometrical observer, and a draughtsman of maps, distinguished for the accurate character of his work. He was afterwards engaged on various railways in the North of England, preparing maps and sections. In 1847, finding railway work unpromising, he accepted an appointment as teacher in Queenwood College, Hampshire, where farming, engineering, surveying, agricultural chemistry, and such useful subjects, were taught. Here he became acquainted with Mr. Frankland, who was afterwards appointed Professor of Chemistry to the Royal Institution. In 1848 they quitted England together and repaired to the University of Marburg, in Hesse Cassel, being drawn thither by the fame of Bunsen as a teacher.

Dr. Tyndall's first scientific paper was a mathematical essay on "Screw Surfaces," but he first attracted the attention of the English scientific world by a paper upon "The Magneto-Optic Properties of Crystals, and the relation of Magnetism and Diamagnetism to Molecular Arrangement," published jointly with Prof. Knoblauch in the *Philosophical Magazine* for 1850. In 1851, after a short sojourn in England, he returned to Berlin to pursue his studies in the laboratory of Prof. Magnus. Here he finished an investigation on "Diamagnetism and Magnecrystallic Action." The same year he returned to London, where he made the acquaintance of Faraday, who conceived a strong liking for him, which never died out.

In 1852 Dr. Tyndall was elected a Fellow of the Royal Society. He gave his first lecture at the Royal Institution on Friday evening, February 11, 1853; and, in June following, he was unanimously elected Professor of Natural Philosophy to

the Institution. After his appointment he devoted himself specially to the examination of the newly-discovered force of Diamagnetism, including the question of Diamagnetic Polarity, and the influence of pressure in producing magno-crystallic phenomena. In 1855 he published, in the *Philosophical Transactions*, a memoir "On the Nature of the Force by which Bodies are Repelled by the Poles of a Magnet," in which an exhaustive comparison is instituted between paramagnetic and diamagnetic phenomena. This paper was chosen as the Bakerian lecture for the year. In a paper entitled "Further Researches on the Polarity of the Diamagnetic Force," and by means of an apparatus devised by the celebrated Wilhelm Weber, he removed the last published objections to the doctrine of diamagnetic polarity, and next applied the doctrine to the explanation of all the phenomena exhibited by crystals in the magnetic field.

From 1856 to the present time he has visited Alpine regions every year, once in company with his friend Prof. Huxley. In the course of these excursions he studied the phenomena presented by glaciers; he ascended Mont Blanc three times; scaled most of the Alpine peaks; and in 1860 and 1862 made two attempts to reach the summit of the Matterhorn. In the second attempt he was stopped by a precipice at a height of 14,200 ft. Next, he not only succeeded in reaching the top of the Matterhorn, but made a complete passage over the mountain, from its southern to its northern base. In April 1868, he, in company with Sir John Lubbock, ascended Vesuvius when the mountain was in partial eruption, and during a short cessation in the discharges from the crater managed to get a peep down the central tube of the volcano itself.

His Swiss journeys have not been without their scientific results. To the *Philosophical Transactions* Professor Tyndall has contributed a series of memoirs on the physical properties of ice, and on the structure and motion of glaciers. He has also treated the subjects of Alpine life and glacial phenomena in a separate volume, entitled *The Glaciers of the Alps.* This volume has been since followed by two others on the same subject.

Dr. Tyndall possesses, in an eminent degree, the faculty of making his ideas plain to others, in clear, simple, and striking language, backed, at the lecture table, with brilliant experiments, which constitute a part of the teacher's text. During Professor Tyndall's term of office at the Royal Institution his researches in the laboratory have been principally in relation to the phenomena of radiant heat. Within eight years he contributed eight elaborate memoirs on this subject to the *Philosophical Transactions.* When he began these researches the whole realm of gases and vapours was supposed to be outside the reach of experiment in reference to radiant heat. But in his first memoir, published in 1861, Prof. Tyndall established not only the existence of absorption and radiation in gases and

vapours, but also their reciprocity, proving, moreover, that between various gaseous bodies differences of absorption and radiation existed far greater than those manifested by solids and liquids. Probably the discovery in connection with this subject, which is destined to bear the most important fruit, as connecting physics and chemistry, is the striking difference manifested between elementary and compound bodies as regards their radiant and absorbent power. It was this discovery which led him subsequently to try the element iodine in a state of solution, and to find in it a filter competent to intercept with marvellous sharpness the visible radiation of the sun and the Electric Light, allowing the invisible to pass freely.

In 1862 Prof. Tyndall published his second memoir "On the Absorption and Radiation of Heat by Gaseous Matter." Here, among other results, we have announced the discovery of dynamic radiation and absorption, and the description of a method of determining the radiation and absorption of gases and vapours without any source of heat external to the gaseous body itself.

In 1863 he published a third memoir "On the Relation of Radiant Heat to Aqueous Vapour." Subsequently to Prof. Tyndall, but, we believe, independently, Prof. Magnus published a memoir "On the Absorption of Radiant Heat by Gases." As far as his researches went they confirmed the results of Prof. Tyndall, except as regards the action of aqueous vapour. In 1863 Prof. Tyndall published the first edition of a work entitled *Heat Considered as a Mode of Motion*, in which he endeavoured to render the dynamical theory of heat accessible not only to scientific students but to all cultivated persons. The work has been exceedingly successful, a fifth edition being now called for in this country, and translations of it having appeared in French, German, and Russian. It has also been republished in the United States. The work contains abstracts of his own researches.

In 1864 he published his fourth memoir "On the Radiation and Absorption of Heat by Gaseous and Liquid Matter," proving that gaseous films not more than one hundredth part of an inch in thickness exhibited a measurable absorption, examining the sifting powers of gases on radiant heat, and extending his researches on dynamic radiation. In the same year he published his fifth memoir, entitled "Contributions to Molecular Physics," which was the Bakerian lecture for the year. At a perfectly dark focus, formed by means of the iodine filter above alluded to, platinum foil was raised to incandescence, yielding all the colours of the solar spectrum. This rendering of invisible heat visible Professor Tyndall has called calorescence. In a paper on "Luminous and Obscure Radiation," published in the *Philosophical Magazine* for November 1864, and in a memoir on "Calorescence," published in the *Philosophical Transactions* for 1866, these subjects are fully treated. In the course of these experiments he proved that the eye may be placed in a focus sufficiently intense to raise platinum to redness, without any im-

pression of light, and without injury to the eye. In 1866 he also published in the *Philosophical Transactions* a memoir on the influence of colour and mechanical condition upon radiant heat. He there defined and qualified the experiments of Franklin, proving, among other things, that white bodies may be far more potent absorbers of radiant heat than black ones. In 1865 Professor Tyndall delivered and published the Rede lecture before the University of Cambridge, and the same year the honorary degree of LL.D. was conferred on him by the University. In 1867 he published a volume of lectures on Sound, which has already been translated into various foreign languages; and in 1868 a tract, entitled "Faraday as a Discoverer," in which he has endeavoured to make clear to the world the achievements of his renowned predecessor.

Professor Tyndall next investigated the chemical action of light upon vapours, and, in connection with this subject examined the physical constitution of the sky. By the condensation of vapours of various kinds into particles so small that their diameters are measured, not by tens of thousandths, but by hundreds of thousandths of an inch, he succeeds in producing a blue which equals, if it does not transcend, that of the deepest and purest Italian sky; and this blue exhibits all the effects of polarisation which have been hitherto observed in skylight.

[We have selected and abridged the preceding details from the masterly biographical sketch of Dr. Tyndall which appeared in the second section of the Royal Institution Papers which were printed in the *Engineer* for Jan. 15, 1869. We continue them from the Institution Proceedings, and other sources.]

Mr. Spottiswoode, Treas.R.S., in his able discourse on the old and new Laboratories of the Royal Institution (of which an abstract appears at page 114 of the present *Year Book of Facts*) says: "Of Faraday's successor, John Tyndall, I am greatly at a loss to speak. In this place his presence seems so near us, his thoughts so subtle, his words—even when rung back to us from those busy cities far away on the other side of the Atlantic—so familiar and yet so stirring, that it behoves us that ours should be wary and few. Few men have brought so large a burthen and bulk of contribution to the common stock of knowledge; but still fewer have inspired in their hearers so strong a love, such ardent enthusiasm, for the subjects of his research."

Mr. Spottiswoode then refers to Dr. Tyndall's first thirteen papers, which were printed in the *Philosophical Transactions*. "In these he established the important fact that if the various gases be arranged in order according to their power, first of radiating heat and secondly of absorbing radiant heat, the order will be the same in both cases. He further proved that the chief absorbing action of our atmosphere on non-luminous heat is due to its aqueous vapour. He applied his discovery to the explanation of many meteorological facts: *e.g.* the great daily

range of the thermometer in dry climates; the production of frost at night in the Sahara; the cold in the table-lands of Asia, &c.

"He discovered also the means of separating the invisible from the visible radiations, and proved that in the case of the electric light the former is no less than eight times as powerful as the latter. He also made the daring experiment of placing his eye at a focus of dark rays capable of heating platinum to redness.

"Since 1866 his attention has been largely occupied in examining the action of waves of high refrangibility (instead of low), as an explorer of the molecular condition of matter.

"In this investigation one obstacle to be overcome was the presence of the floating matter in the air. The processes of removal of these particles became the occasion of an independent research, branching out into various channels; on the one hand, it dealt with the very practical problem of the preservation of life among firemen exposed to heated smoke; and, on the other, it approached the recondite question of spontaneous generation.

"He subjected the compound vapours of various substances to the action of a concentrated beam of light. The vapours were decomposed, and non-volatile products were formed. The decompositions always began with a blue cloud, which discharged perfectly polarised light at right angles to the beam. This suggested to him the origin of the blue colour of the sky; and as it showed the extraordinary amount of light that may be scattered by cloudy matter of extreme tenuity, he considered that it might be regarded as a suggestion towards explaining the nature of comets.

[Mr. Spottiswoode then exhibited the polarisation of light scattered by small particles suspended in the medium traversed by a beam from the electric lamp, employing for the purpose the chromatic effects due to the circular polarisation of quartz.]

"His volume of contributions to molecular physics in the domain of radiant heat, which contains only his original investigations on this subject, would alone suffice to show what is doing in the laboratory of our Institution.

"If we compare him to Faraday at the same time of life, he has still many years of intellectual energy, the conversion of which into its scientific equivalent may, perhaps, be effected within these walls."

The *Year Book of Facts*, 1859, p. 289, contains a letter "from a most earnest and philosophic investigator of the glaciers of Switzerland," and describing the ascent of Monte Rosa without a guide, addressed by Prof. Tyndall to Prof. Faraday, but too long for quotation here. "A Swiss Mountain Climber" remarks upon this ascent: "From my knowledge of the difficulties of scaling Mont Blanc and Monte Rosa, the dangers of the latter exceed those of the former, but to reach the summit of Monte Rosa alone is a feat of daring and strength never heard of."

The *Year Book of Facts*, 1860, p. 147, contains Prof. Tyn-

dall's paper, written after spending a night upon the summit, "On the Establishment of Thermometric Stations on Mont Blanc," communicated to the British Association.

The *Year Book of Facts*, 1868, p. 116, contains a paper by Prof. Tyndall on "Sounding and Sensitive Flames." The sounding of a hydrogen flame within a glass tube had been noticed by Dr. Higgins, and the subject had been investigated by Chladni, Faraday, Wheatstone, and other philosophers; and the jumping of a naked fish-tail gas flame, when near flaring, in response to musical sounds, was noticed by Lecomte. Prof. Tyndall's lecture was an expansion of these discoveries.

The *Year Book of Facts*, 1872, p. 37, contains Prof. Tyndall's lecture delivered at the Royal Institution, upon "The Scattering of Light," which was, in point of fact, a discourse upon Domestic Water Supply. Having established that the visibility of the track of a beam through water depended upon particles, by which the light was scattered, Prof. Tyndall examined, by means of a concentrated luminous beam, samples of the water supplied to their customers by the various London Water Companies. The turbidity revealed was, in every case, sufficient to make the audience regard water as a very undesirable beverage. This paper explains the water supply yielded by the English chalk formation as of the greatest attainable purity, copious in quantity, and easily accessible for the supply of the metropolis. Its hardness can be removed by Clark's process, and it can be delivered almost free from organic impurity, and perfectly soft.

Quite recently Prof. Tyndall delivered at the Royal Institution a discourse on the Acoustic Transparency and Opacity of the Atmosphere, and followed it up by submitting to the Royal Society an elaborate paper "On the Atmosphere as a Vehicle of Sound." He first referred to the great loss of life and property at sea during foggy weather, and said that earnest men had in consequence endeavoured to establish a series of Sound Signals sufficiently strong and powerful to afford warning and guidance to mariners. The lecture embraced the results of observations which Prof. Tyndall, in conjunction with the Elder Brethren of the Trinity House, had made from the coast of Kent. Two stations were established at the South Foreland, and instruments, including powerful steam whistles, trumpets, a steam syren, and guns, were placed there, the effects of which were noted by observers afloat. The experiments commenced on May 19, 1873, and continued to the spring of the present year. They embrace the investigation of the agency by which sounds are quenched in the atmosphere, proving the principal of these to be the irregular admixture of transparent aqueous vapour with the air. This mixture produces what Professor Tyndall calls *acoustic clouds* on days of perfect optical transparency; while the investigation demonstrates that on days of the densest fog the air may, to an extraordinary extent, be transparent acoustically. In the presence of these facts the

connection hitherto supposed to exist between the optical and acoustical clearness of the atmosphere entirely disappears.

These acoustic clouds are never absent from our air, and it is they which, drifting between the observer and the source of sound, produce the variations of intensity observed by every-body in the case of church bells, not only from hour to hour but from minute to minute.

Through the melting away of those invisible acoustic clouds, a sound listened to on July 3, at 2 miles' distance from the South Foreland, would have augmented forty-fold in intensity between the hours of 2 P.M. and 7 P.M. On the other hand, the visible clearing of the atmosphere from ordinary fog is frequently accompanied by the generation of acoustic clouds which render the medium highly impervious to sound.

The sound refused transmission by those acoustic clouds is sent from them by reflection in echoes of extraordinary strength and duration. These echoes require no visible clouds, as supposed by Arago, for their production; they are returned to the observer, when he takes up a proper position, from absolutely invisible walls. A second, for example, after the syren begins to sound, the aerial echoes strike in as if from a band of trumpeters suddenly established in the air, and afterwards moving rapidly away. About 20,000 blasts have been blown from the syren; a still greater number from the horns; while many hundred shots have been fired from the guns. The aerial echoes varied in strength and durations, but they were never absent, whatever might be the condition of the air.

In April last year Prof. Tyndall read to the Royal Institution "Some Observations on Niagara," in which he observes that there was little accuracy in the estimates of the first observers of the cataract." Startled by an exhibition of power so novel and so grand, emotion leaped beyond the control of the judgment, and gave currency to notions regarding the water-fall which often led to disappointment."

Prof. Tyndall then records the history of Niagara from 1585, the date of the first printed allusion to Niagara. In 1721 Charlevois states the result of his observations: "For my part, after examining it on all sides, I am inclined to think that we cannot estimate it less than 140 feet or 150 feet"—a remarkably close estimate. At that time, viz. a hundred and fifty years ago, it had the shape of a horse-shoe, and reasons are subsequently given for holding that this has always been the form of the cataract, from its origin to its present time.

"As regards the noise of the cataract, Charlevois declares the accounts of his predecessors—which, I may say, are repeated to the present hour—to be altogether extravagant. He is perfectly right. The thunders of Niagara are formidable enough to those who really seek them at the base of the Horseshoe Fall; but on the banks of the river, and particularly above the Fall, its silence, rather than its noise, is surprising. This arises, in

part, from the lack of resonance; the surrounding country being *flat, and therefore furnishing no echoing surfaces to reinforce the* shock of the water. The resonance from the surrounding rocks causes the Swiss Reuss at the Devil's Bridge, when full, to thunder more loudly than the Niagara."

The "Observations" extend to seventeen pages of the Royal Institution Proceedings. The descriptive details are very interesting, the main objects being the correction of errors and the substitution of right views for opinions hastily formed. We have only space to quote Prof. Tyndall's conclusion:

"We may say a word regarding the proximate future of Niagara. At the rate of excavation assigned to it by Sir Charles Lyell, namely, a foot a year, five thousand years or so will carry the Horseshoe Fall higher than Goat Island. As the gorge recedes it will drain, as it has hitherto done, the banks right and left of it, thus leaving a nearly level terrace between Goat Island and the edge of the gorge. Higher up it will totally drain the American branch of the river, the channel of which in due time will become cultivable land. The American Fall will then be transformed into a dry precipice, forming a simple continuation of the cliffy boundary of the river Niagara. At the place occupied by the fall at this moment we shall have the gorge enclosing a right-angle, a second 'whirlpool' being the consequence of this. To those who visit Niagara a few millenniums hence I leave the verification of this prediction. All that can be said is, that if the causes now in action continue to act, it will prove itself literally true."

Besides his original memoirs, which have been collected in two volumes, entitled respectively "Researches in Diamagnetism and Magne-crystallic action," and "Contributions to Molecular Physics in the domain of Radiant Heat," Professor Tyndall has published the following works, some of which have been already referred to:—"The Glaciers of the Alps;" "Heat as a Mode of Motion;" "Lectures on Sound;" "Lectures on Light," delivered in the United States; "Fragments of Science;" "Faraday as a Discoverer;" "Hours of Exercise in the Alps;' "The Forms of Water;" and "Notes on Light and Electricity.

At tne last Oxford Commemoration he received the honorary degree of D.C.L.; which is a significant proof of the growth of liberal ideas in that great seat of learning.

THE CIRCULAR IRON-CLAD "POPOFFKA NOVOGOROD," FOR THE IMPERIAL RUSSIAN NAVY.

(*See Vignette.*)

About three years ago, the accompanying design was submitted by Admiral Popoff to the Imperial Russian Admiralty, with the object of obtaining a ship of small dimensions which should carry an armament of a few guns of the heavier class, be capable of steaming at a speed sufficient for all purposes of coast defence, and at the same time be well-protected by armour-plating. The principle of the design is, that in comparison with ships of ordinary form, circular vessels have greater displacement with the same weight of hull, and therefore increased means for protecting the water-line with a strong belt of armour, the decks with thick plating, and the guns with a strong armoured breastwork; thus insuring, in accordance with modern principles, the highest amount of safety for ship and crew. The great advantage of circular form is that it enables a vessel to be built of small draught of water, with the greatest displacement as compared with weight it is possible to give her. From this account it is evident that the present idea of a circular vessel has nothing in common with any project of the kind which has hitherto appeared, but is, in fact, an extraordinary development of the principle carried out by Mr. Reed in the British Navy, of shortening ships for the purpose of obtaining hardiness and reduction of weight, and broadening them to increase the displacement.

Popoffka Novogorod was launched in May last, in the presence of the Grand Duke Constantine, to whom, as High Admiral of the Fleet, and to Admiral Krabbe, Minister of Marine, belong the credit of accepting the design, and ordering the construction of this vessel in accordance with it.

The extreme diameter of the hull of the *Novogorod* is 101 ft., her draught of water, with all weights on board, 12 ft. 6 ins.; to which draught must, however, be added the depth of the longitudinal false keels. Her displacement is 2,491 tons.

The form of the midship (and of any radial) section is as follows: the bottom is circular and flat, and parallel to the low-water line, with a diameter of 76 ft.; and from the turn of the bilge round the bottom the sections are curved, ascending in the form of quadrants of circles where semi-diameters are equal to the depth of the vessel. The framing of the hull is composed of a network made of radial frames and circular stringers, plated both outside and inside. The armour extends 1 ft. 6 ins., and 4 ft. 9 ins. below the load-water line; the plates being placed upon a compound backing formed of T. Hughes' patent hollow girders, 7 in. deep, with the spaces between and within them filled with teak. Hollow girders are rivetted to the plates behind the armour in two thicknesses, and are supported from behind with strong frames, forming continuations of the deep beams of

the upper deck; seven hollow girders are equivalent in resisting power to two additional inches of armour; thus, the thickness of solid armour-plates is reduced to 7 ins. instead of 11 ins., so that superiority in the material of which the solid armour-plates are made is secured, and at the same time good support is afforded to the armour from behind, and the strength of the ship increased.

The upper deck beams run radially, and are connected with circular earlings. The protective deck plating is $2\frac{3}{4}''$ thick, and is worked in three thicknesses. In the *centre of the ship stands the breastwork 30 ft. 9 in. in diameter, and 7 ft. high. The breastwork is open at the top, to allow the guns to be fired over it en barbette*, thus facilitating accuracy of training and giving an all-round fire. Two 11 in. 26-ton guns, firing projectiles (550 lbs. Russian weight), with a charge of 91 lbs. (Russian weight), are mounted on separate platforms which can be moved independently, or together when it is required to point both guns at the same time on one object. For that purpose there is a hollow cylinder in the centre, which serves as a scuttle, through which powder, shot, and shell may be taken within the breastwork, and forms the axis round which each of the platforms, with its carriages and guns, rotates. The rollers on which the platform rests move in two concentric circular paths, the motion being regulated by a special circular brake, which will stop the guns at any moment.

The engines for propelling the ship, six in number, each of 80 nominal horse power, working in the aggregate up to 3,000 indicated horse power, give motion to six independent screws, having parallel shafts placed in a longitudinal direction. There are two principal reasons for this arrangement: First, the draught of the ship is so small, that with fewer screws the large engine-power could not be developed; and secondly, the ships which are made to depend wholly on steam, as the motive power, should be provided with as many independent engines as possible, in order to reduce to a minimum the chance of breaking down so as to stop their action.

The ward-room and captain's cabins are placed inside the highest superstructure built over the armoured deck, in the forepart adjoining the breastwork. All openings in the deck are provided with armour-covers, and when these are closed the ventilation is maintained in an efficient state by forcing large volumes of air through the bottoms of the breastwork, and distributing it in all directions inside. Steam-fans are employed for this purpose. The materials were all prepared at St. Petersburg, and were sent by rail to Nicolaef, and there put together. The results of the trials, both as regards speed and other performances, have given great satisfaction to the Russian authorities.

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YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

THE BESSEMER CHANNEL STEAMER.

The ships proposed by Mr. Bessemer and Mr. Reed will reduce the disagreeable features of the Channel passage to a minimum. They will be so swift as to make the time spent upon the sea as short as possible; and they will possess qualities which will insure them great steadiness among the waves they will meet. The vessels are double-ended, and are propelled by four large paddle-wheels, two at each side. The ends are kept low for the purpose of reducing the motions produced by the action of the wind and of the sea; and the middle portion is made sufficiently high to enable them to steam at a great speed against the worst seas they will have to meet. A rudder is fitted at each end, with means for locking, so that the ship will be able to steam in either direction, and will not require to be turned round in harbour. The great peculiarity of these ships is that each will contain a large saloon, designed by Mr. Bessemer, suspended in the middle of the ship in such a way that it can be moved about a longitudinal axis parallel to the keel. The motion of this saloon, which would be set up when the vessel rolled if left free to move, will be governed by an hydraulic apparatus, and will be completely under the control of one man, whose duty it will be to keep the floor of the saloon, under all circumstances, in a line with a spirit-level. Each steamer will be 350 ft. long, 40 ft. wide along the deck-beam, and 40 ft. wide across the paddle-boxes. She will draw 7 ft. 6 ins. of water, the same as the present steamers, and will be propelled at the speed of 20 miles an hour by two pairs of engines of the collective power of 4,600 horses. The centres of the two pairs of paddle-shafts will be 106 ft. apart.

The passenger accommodation will consist of the Bessemer saloon, which has a fixed cabin at one end, between decks, and a line of small cabins on each side of the ship, between the paddle-boxes; that will include a total length of 150 ft.

But one of the greatest advantages of this saloon is, that whatever motion the ship may take from the waves—and this, from the adaptation of her form to passivity among channel waves will be slight—the saloon will be practically free from it. It is in the middle of the ship, as regards length and breadth; and the axis of rotation is at a height where there is least motion, so that as regards its position it is one in which the vertical and lateral motions produced in every part of the ship

by the pitching and rolling will be so small as to be inappreciable. The cabin will also have no sensible pitching motion, for the form of the vessel is such as to make it impossible for the sea of the Straits of Dover to raise the ends very considerably, and even the small effect produced at the ends of the ship will be reduced to one-seventh at the extremities of the cabin. The rolling of the ship on the intended service cannot be very great, but such as it is, it will not be communicated to the cabin, for the perfect action of Mr. Bessemer's hydraulic apparatus is an established certainty, and not a matter of speculation, and it will always insure the floor being kept level.

In addition to the saloon being thus made practically independent of the irregular movements of the ship as a whole, it will also be made free from sharing in the tremulous motions set up by the working of the engines, or the shocks of waves against the side. This will be effected by resting the supports of the saloon upon massive beds of indiarubber, and thus making it impossible for any vibratory motion to be transmitted from the ship to the saloon. The floor will also be freed from vibration by special means.

The substitution of steamers of this type for the present ones will be a great boon to numerous travellers, even according to the worst estimate that can be put upon their merits. If the saloon could not be kept level, and if lateral and vertical motions could not be prevented being felt, or if there should be a slight falling off in speed—none of which events are likely to happen—still, the greatly increased accommodation provided, the diminished effect the waves will have upon these ships to produce the motions complained of, and the superior speed they will possess to the present ones, upon the worst supposition that can be made, constitute claims that will ensure them the approbation of all who have ever suffered the misery and degradation of rough passages across the Channel in the existing steamers.—Abridged from *Naval Science*, No. 4.

ONE HUNDRED MILES AN HOUR.

It will scarcely be disputed that to possess the power of traversing long distances at a velocity of 100 miles an hour would be advantageous to a very large section of the community. The average speed on the best mail-coach lines in 1829 and 1830 was a little over ten miles an hour; and many individuals possessing the power of thinking clearly and writing well argued that no augmentation of mail-coach speed was necessary, desirable, or likely to produce any benefit to the nation. The advent of railway speeds sufficed in a very short time to prove that all arguments of this kind were fallacious. In 1830 speeds of thirty miles an hour were regularly attained by railway trains, and the advantages to be derived from this rate of travelling were quickly and keenly appreciated by the public. In the same way, and for the same reasons, it is certain that the benefits to

be gained by the power of reaching Liverpool in two hours, or Vienna, for example, in 12 hours, would be quickly recognised by the nation; and it is probable that a sufficient number of passengers, at considerably higher fares than those which are now paid, would be obtained on any great main line to justify directors in putting on one or two extra trains in the day which would maintain when running an average velocity of 100 miles an hour. How much the public would be content to pay for such a privilege it is of course impossible to say with accuracy; but we believe there is a fair probability that trains travelling at 100 miles an hour could be made to pay provided the cost of running them was not enormously in excess of the cost of running an ordinary express train timed—say, at 45 miles an hour. In considering the subject, this question of cost is one of the most important features to be dealt with. A more important question however, is this:—Is it possible to attain, or, having attained, to maintain, at any price whatever, or under any conceivable conditions, a velocity of 100 miles per hour? This question must be settled first, as it would be absurd to attempt to calculate the cost of an impracticable undertaking.—*The Engineer.*

AN ELECTRO-MAGNETIC SHIP.

An attempt has lately been made in one of our largest seaports to propel a small yacht by Electro-magnetism. The arrangement may be described as follows:—The vessel is fitted with an ordinary screw propeller, the shaft being continued forward to an engine-room nearly amidships. In the engine-room is fitted the prime-motion shaft, disposed horizontally parallel to the screw shaft, motion being transmitted by a pitch-chain and wheels. Upon the prime-motion shaft are carried three cast-iron wheels, each containing seven "armatures," *i.e.* cast-iron projections. Each "armature" is set in advance of the corresponding one of the set next on the shaft. These are acted upon by wrought-iron electro-magnets placed underneath, and surrounded by wires connected to a battery, which is situated in the engine-room. Contact is made and broken by short levers worked by cams on the prime-motion shaft. It will be seen that the cams, being placed at a suitable angle on the shaft in relation to the "armatures," the electro-magnets are alternatively in a state of vivid action and neutrality, according to the position of their corresponding "armatures." As the attractive force exerted on each armature will vary inversely as the square of its distance from the magnet, it is evident that as soon as each armature has passed through so much of its revolution as to be some distance past its magnet, the attraction tending to retard its revolution will be very small, and the cam can be so arranged as to make contact again, and form an attraction for the armature coming next in turn in the revolution of the shaft.* The

* A similar method, but applied to an ordinary reciprocating rod on the main shaft of the engine, was exhibited about twenty years ago by Mr.

entire machinery requisite is mentioned above, with the exception of the cast-iron framing to support the moving parts, and the size and weight of the whole form a striking contrast to the dimensions of the engine and boiler-room formerly containing the machinery which it is intended to supplant. Although not approving of the particular manner on which the principle has been worked out in this instance—indeed, while expressing grave doubts if the arrangement will work at all—we cannot help thinking that a step has been taken in the right direction, and that the day is not so very far distant when, having travelled through the intermediate improvements in the steam-engine itself, we shall cast it aside as altogether too cumbrous and complicated, and find ourselves ploughing the ocean in vessels propelled by a motive-power which, while occupying a comparatively insignificant portion of the vessel, will yet be strong enough to drive her at a speed hitherto unattempted.

It may be here remarked that any attempt at gauging the future—even the future of but very few years—must necessarily be sketchy and incomplete; indeed, the predictions of the engineering prophet, like those of other prophets of modern date, must be received with a great amount of caution. It is true of the mechanical world, as of the world outside, that "coming events cast their shadows before;" but, like the mirage of the desert, shadows are sometimes cast without the ultimate presence of the substance; and many promising discoveries which, at first, appear destined to revolutionise the entire profession of the mechanic, have finally to sink into oblivion, which is the natural end of inventions lacking the stamp of practicability and commercial economy. On the other hand, when the boundary line of perfection seems nearly drawn, and there appears little to do but to gaze retrospectively upon the triumphs of the past, some great intellect arises, and, with the aid of some well-timed discovery, shows the world of science that the spirit of progress still lives. Such a mind was that of James Watt, and such an influence did he exert; and who can tell at what moment a discovery like his masterpiece of separate condensation may be made.—E. J. Reed, C.B., *Naval Science*, No. 6.

AN ENGINEERING VIEW OF RAILWAY ACCIDENTS.

The members of the Institution of Civil Engineers held their first meeting after the Christmas recess on Tuesday evening, the 13th of January 1874, when the newly elected president, Mr. Thomas E. Harrison, delivered an inaugural address. After commenting on the various public works in progress, under the direction of British engineers, in different parts of the world, instead of economy governing the actions of directors, Mr. Harrison had no hesitation in saying, when it was clearly shown by

Thomas Allan, the distinguished electrician. We remember inspecting the working model in Adelphi Terrace.

their responsible officers that the adoption of any improvement would tend to promote the safety of the public, that improvement was at once carried out. There was also a popular delusion that the various recommendations made to the railway companies from time to time by the officers of the Board of Trade, such as the block system, interlocking of points, &c., were the invention of those officers. The fact was that not one of those systems of inventions, or any new idea in connection with the working of railways, had ever been suggested by those officers. The railway companies also stood at a great disadvantage with the public in respect to the reports which were from time to time made by the Government inspecting officers, whose dictum was never questioned by the public. Although railway officers of great experience constantly differed from those officials in the conclusions at which they arrived, the railway companies felt that any appeal against those reports was useless, and practically judgment was allowed to go by default. In making their reports, the officers of the Board of Trade were in the position of *ex post facto* judges. Should the country at any time become the purchasers of railways, those officers would soon find the difference in their position when the responsibility of working fell on them.

Captain Tyler, in his valuable Report on Railway Accidents in 1872, said:—"Whatever be the amount of care taken, the item of human fallibility will still remain, and will always be the cause of a certain number of accidents." And he stated that in 180 cases of accidents out of 238, "negligence, want of care, or mistakes of officers were apparent." This was a subject to which for years past Mr. Harrison had given a great deal of attention and anxious thought, and he attached much more importance to the item of "human fallibility" than Captain Tyler did. It was an undoubted fact that accidents often occurred in the hands of the most experienced men in a moment of forgetfulness. Thus an accident happened under the block system owing to the momentary forgetfulness of a signalman, who had been selected to instruct the others in their duties. Some years ago the officer in charge of the chaldron waggons building on the North-Eastern Railway pointed out that the tops of the waggons came so close together that any one standing on the soles might be jammed, and he recommended that the soles should be lengthened. The order was given for the alteration to be made; but within a few weeks the official referred to was killed in the very manner he had suggested, though no man living knew the danger better than he did. The president himself was nearly killed twenty years ago by stepping beyond the end of the station wall at Darlington, without looking to see whether there was any engine coming in the other direction. It happened that there was, and he was caught by the engine buffer and knocked several yards, though if he had been thinking only of the railway he should have known the danger. It was not wilful

negligence, but momentary forgetfulness, to which all were liable, that had been and ever would be the cause of many railway accidents. It might be considered as settled that the block system would, as soon as it was possible to complete the necessary works, be introduced throughout the whole of the railways in the United Kingdom; but its introduction at once increased that element of danger—"human fallibility"—to a very large extent. In the case of the North-Eastern system it was calculated that on the completion of the block system the number of signalmen would be increased from 500 to 2,000. Observation and inquiry had clearly demonstrated that the introduction of the block system, and of additional signals, caused the engine-men and other railway servants not to keep the same look out, or to use the same care, as on a line apparently less protected. This was only human nature, but Mr. Harrison did not intend to argue from this against the introduction of the block system. When, however, it was put forward as a perfect security to railway travelling, he wished to point out that it introduced another important element of danger, generally much underrated, and that railway officials might sometimes hesitate to recommend the adoption of the block system from this circumstance.

The question of the effect of the labour market on railways, both in their construction and working, had come forcibly home to every one connected with them. It was not too much to say that all new works were now costing from 30 to 40 per cent. more than they did a few years ago, and nearly double the time was required to complete them. Where the works were not near to large towns it was difficult to get men at all, and as a rule they did not do the same amount of work as formerly. In the important colliery and iron districts of the North of England there was great difficulty in getting men to do night-work—such as emptying the waggons at the furnaces or filling coke after a certain hour at the coke ovens—and pitmen limited their work in many cases to four days a week. This created a great difficulty in getting traffic carried, and would, if continued, necessitate an enormous increase in rolling stock, sidings, and engine-power, for at present the work got out of a mineral waggon in these districts was little more than two-thirds of what it was three or four years ago. The rapid development of traffic, the difficulties caused by men limiting their hours of work, and the introduction of the block system, had necessitated a remodelling of the old mineral railways in the North of England, which it would take a long time to complete. On the general question of the policy of railway companies towards the public, Mr. Harrison had always advocated great liberality, especially in giving increased facilities and accommodation, in the reduction of fares in populous districts, and in rendering every encouragement to parties able and willing to develop the industry of the country; and, having watched the effects of this

policy in many important cases, he knew of no instance in which it had not been successful. As to the policy of railway companies towards each other, though an advocate for unlimited and indiscriminate running powers, he should not hesitate to interchange or grant running powers whenever it could be shown that public convenience would be promoted by it; and he would also allow the running company to carry local passengers, receiving a small percentage for the service.

THE CENTRAL DOME OF THE VIENNA EXHIBITION BUILDING.

At the Royal Institute of British Architects, Mr. John Scott Russell, F.R.S., has described his own work in the great building at Vienna. "You all remember (says Mr. Scott Russell) the marvellous excellence of the original Exhibition building in Hyde-park, and you all have recognised the distinguished merit of the Crystal Palace at Sydenham. As I am intimately acquainted with the story of these two buildings, which are the first types of a new nature of construction, I will venture to say that some of the ablest mechanical engineers of our time, and some of the ablest members of your Institute of Architects, combined their highest efforts to give excellence to their common work, that the two professions co-operated cordially and harmoniously, and that they and we are all proud of the results.

"In like manner I have to say for my own iron building at Vienna, that from the beginning to the end of the design I am deeply indebted to members of your profession for kindly help and cordial co-operation. When I made the first sketches of the Vienna building, the designs were all drawn for me by Mr. John Crace, the worthy son of a father who had long before acted a distinguished part in beautifying our two first palaces. It was on his drawings that the design of my dome was first shown at Vienna. Where these drawings of his do not correspond to the work as executed, it is because the rest of the buildings all around my dome were decided to be of a quite different style, and because, as they were to form parts of one great whole, it became expedient that the same Vienna architects who designed the architecture of the surrounding portions should design the architecture of that, so as to be in harmony as a whole. I have great pleasure in saying, that in Vienna I received as genial sympathy and as cordial co-operation in the great work in which we were engaged, as I have always received in any matter of joint interest from members of this Institute. The architectural features and decorations of the dome, as now executed, are the work of M. Hasenauer, who, at an early age, has earned high distinction, and who inherits the traditions and talent of your profession from his distinguished father.

"The iron dome at Vienna is, I believe, the largest vaulted roof in the world. I think it covers nine times the ground of the dome of St. Paul's, eight times the area of the dome of St.

Peter's, and seven times the area of the dome of St. Sophia, at Constantinople.

"The dome is 360 ft. in diameter, and 1,080 ft. round. It stands on a ring of thirty columns, 36 ft. apart all round the circumference. Within this ring of columns there is no support. The upper dome, 100 ft. diameter, admits light by a series of windows, 40 ft. high and 10 ft. wide, between thirty columns which carry the upper dome. I fancy the English architect will get the best feeling of the magnitude of this interior by going into St. Paul's Cathedral, looking up to the inner dome, and then imagining all the columns that carry the roof done away, and the upper dome left suspended in the air, but sustained by a lower dome resting only on the outer walls. The area covered, the height, and the dimensions, are sufficiently near to give the true impression according to my feelings, and I hope, therefore, to yours.

"Although the dome is carried on these thirty columns at intervals of 36 ft. all round, and although the structure of the whole dome conforms to this symmetric division, two more columns are introduced by intercolumniation at the two entrances to the grand avenues, making in all thirty-two columns. These give beauty, and do not destroy symmetry.

"The slope of the cone is thirty degrees. The length of the slope on all sides is 200 ft. The roof is formed of 360 iron plates, tapering uniformly upwards from the circumference to the apex of the cone. They are riveted like the plates of a ship, each row of plates covers one degree of the circle, each bottom plate is one yard wide between the lines of rivets, and one metre wide over the lap.

"The thirty columns which carry the cone stand round the circle at 12 degrees apart, except at the two intercolumniations. They are 36 ft. from centre to centre; each carries an arch and an upper gallery all round the inside. These columns are 80 ft. high.

"The heights of the whole in round numbers are—columns 80 ft.; cones, 100 ft.; windows, 40 ft.; lantern and crown, 60 ft.; say 280 ft. from floor to crown, besides foundations of 12 ft. to 20 ft.

"This conic dome roof has no visible external wall; it is surrounded by a circular ring building, which consists of the great central nave of the longitudinal axis of the main building, carried circularwise round the cone, and forming, so to speak, a circular aisle, or series of side-chapels, all round about it. The conic roof, therefore, as seen from the exterior, crowns the large low buildings by which it is surrounded, and seems merely to grow out of them, and to group them round it, into one whole, of which it is the centre. The whole outside decoration of both was meant to harmonise them, and not to give predominance to part. This circular ring, nave, or arcade, is 40 ft. wide by 80

ft. high, carried on a second ring of outer slender columns, and opening out into four enclosed courts, or gardens, by large semicircular windows and many doors. This arcade extends the circle of the central building to 440 ft. diameter. It has the great convenience of forming a continuous communication through the entire length and breadth of the building with all the main entrances, without disturbing the central area of the great dome—a quality of much practical convenience."

INTERNATIONAL EXHIBITIONS.

HER Majesty's Commissioners for the Annual International Exhibitions propose, as a feature of each year's Exhibition, to have a collection of objects illustrative of the Ethnology and Geography of various races and parts of the British Empire. It is intended to pursue the work systematically, in the hope of ultimately forming a great national museum of the empire. They will be arranged for the present in the galleries of the Royal Albert Hall. Many portions of the empire are inhabited by aboriginal races, most of which are undergoing rapid changes, and some of which are disappearing altogether. These races are fast losing their primitive characteristics and distinguishing traits. The collections would embrace life-size and other figures representing the aboriginal inhabitants in their ordinary and gala costumes; models of their dwellings; samples of their domestic utensils, idols, weapons of war, boats and canoes; agricultural, musical, and manufacturing instruments and implements; samples of their industries, and in general all objects tending to show their present ethnological position and their state of civilisation. It is proposed to receive for the Exhibition of 1874 any suitable collections, which will be grouped and classified hereafter in their strict ethnological and geographical relations. As, however, there is at present great public interest in the various tribes inhabiting the West Coast of Africa, including the Ashantees, all objects relating to the Fantees, Dahomeys, Houssas, and the neighbouring tribes, are especially desirable. The Indian Empire, the Eastern Archipelago, the Islands of the Southern Hemisphere, are also able to afford abundant and valuable materials for the proposed Museum. Her Majesty's Commissioners confidently appeal to the civil, military, and naval officers of the British Service throughout the Queen's dominions to assist in these collections.

THE AMERICAN INTERNATIONAL EXHIBITION OF 1876.

THE Philadelphia correspondent of the *Times*, in a letter dated the 7th inst., writes as follows concerning the Exhibition of 1876:—"The plan of the buildings for the American Centennial Exposition at Philadelphia in 1876 has at length been determined upon. A great deal of trouble has been taken to secure the best design for their purpose by the Centennial Commission. The matter was opened to general competition, and

43 different plans were presented by architects in all parts of the country. From these, after considerable examination, ten were selected, the designers of each being permitted to revise and alter the details, and having for this purpose access to all the others. There was then a second competition of the revised designs, from which the successful plan was chosen. This design is by Calvert Vaux and G. K. Radford, of New York, being somewhat modified by details taken from a design furnished by Sims and Brother, of Philadelphia. The building is rectangular, 2,040 ft. long by 680 ft. wide, with a greater width at the centre and ends extending to 962 ft. The governing dimension on the plan is a square pavilion 136 ft. on each side. The building itself is 15 of these pavilions long and 5 wide, there being octagonal open spaces between them, providing ample side lights. This plan covers nearly 43 acres, but it can be indefinitely extended if necessary. These pavilions have vaulted domes, the arches connecting them having 100 ft. opening, while the interior octagonal courts between them are 36 ft. in diameter. There are altogether in the plan 65 of these pavilions. The three rows of pavilions in the centre of the plan will practically be a spacious vaulted hall 408 ft. wide by 2,040 ft. long, while there is to be a similarly vaulted transept 408 ft. wide and 962 ft. long. The vistas, therefore, extend to 962 ft. and 2,040 ft., there being views from end to end in all directions, and the committee who selected the plan say that the interior effect of such a building can be made more impressive than that obtained in any exposition building erected down to this time. The exterior view, however, is not very imposing. The materials to be used chiefly are iron for the main arches and brick for the gables. The structure, which can readily be erected during 1874 and 1875, it is estimated will cost from 3,500,000 dols. to 4,000,000 dols. There is also to be erected, as an adjunct, a permanent 'Memorial Hall,' a structure of elaborate architectural design, which is intended to remain permanently on the Exposition Grounds in Fairmount Park, after the other buildings shall have been removed. This Memorial Hall will be used as an Art Gallery during the exposition, and will cover about an acre and a half. Messrs. Collins and Autenreith, of Philadelphia, are the architects of this part of the work. Some modifications are to be made, so that the hall will be completed in time for the opening of the Exposition. Work will begin as soon as possible upon all these structures, and there being a considerable number of building mechanics and labourers now out of employment in Philadelphia, the extensive operation will be entered upon at the right time to aid them. Of the main building, 36 acres will be devoted to the industrial exhibition, and other structures are contemplated, so as to have a separate machinery hall covering ten acres, and an agricultural department of five acres. There also will be a large conservatory. The General Director of the Exposition is Alfred T. Goshom, of

Cincinnati, and the opening is to be on April 19, 1876, the anniversary of the battle of Lexington."

IMPROVED COMPOUND MARINE ENGINES.

THE screw steamer *Teniers*, owned by Messrs. Lamport and Holt, which lately completed her cargo in the Victoria Docks and sailed for the West Indies, was fitted for her present voyage with new Compound Engines, upon a plan which the owners have had in use for eight or ten years past, but which during that period has been subjected to various modifications and improvements. As now carried out, it is found to effect so considerable a saving of fuel, at the cost only of a comparatively small diminution of speed, that it is likely to be generally adopted for steamers from which very quick passages are not required.

The principle of the "compound" Steam Engine, from which so much good and economical work has of late years been obtained, is that it has both a high and a low pressure cylinder or cylinders, and that the steam which has done duty in the former is made to do duty also in the latter, before it is suffered to escape. The Compound Engine was first patented by Arthur Woolf, in the year 1804; and he placed his two cylinders in a vertical line, one above the other, and worked them by a single crank. Since that time a great many experiments have been made in relation to the subject, and almost every conceivable combination of cranks and cylinders has been tried; but the accepted type at present is the two-cylinder engine, with the cylinders placed either vertically or side by side. Messrs. Lamport and Holt employ the former construction, with a single crank, and thus return almost precisely to the principles laid down by Woolf seventy years ago. In now appears that, if his invention had been earlier appreciated at its true value, many millions of tons of fuel, and many hundreds of thousands of pounds sterling, would have been saved. The present price of fuel is so high, and its unnecessary consumption is so much to be condemned, on account of the influence which the coal supply exerts over the cost of iron and of many other commodities, that shipowners will often find it necessary to make quickness of passage subordinate to other considerations, and will be forced to inquire how they may safely convey the largest cargoes from port to port at the best paying speed, and with the least expenditure of coal and stores, rather than how they may attain the highest speed without reference to its cost.

As an illustration of the different ways in which ocean steam traffic may be conducted, we may take two imaginary vessels. The first, vessel A, carries 3,500 tons of general cargo and coal, and is propelled at the rate of 10 knots an hour, by engines of 1,200 indicated horse-power, and with a piston speed of 460 ft. per minute. She will consume 22 tons of coal in 24 hours, and will complete a run of 3,000 miles in 12½ days. In this time

275 tons of coal will be burnt; and if we allow her to have three days' coal remaining as a surplus supply, we must deduct 341 tons for coal stowage from her total capacity. This will leave 3,159 tons of paying freight.

Let us now take steamer B, of the same capacity as the former, but making 14 knots an hour, and consuming 75 or 80 tons of coal a day—say 700 tons—to accomplish her 3,000 miles in nine days. Add three days of surplus supply, and we have to deduct 925 tons from her stowage, leaving only 2,575 tons of paying freight. This steamer will complete 12 voyages to and fro while the former completes 10; so that, in the course of 12 months, 63,180 tons of general cargo would be carried by A, against 61,800 tons carried by B.

To accomplish this work, the steamer A would consume 5,500 tons of coal, say at a cost of 6,800*l.*, and the steamer B would consume 16,800 tons of coal, at a cost of 21,000*l.* The slower steamer would beat the faster one, in the year, by no less than 1,380 tons of freight, and 11,300 tons of coal—the latter at an estimated value of 14,200*l.* It is a serious question whether the advantage to passengers of saving 3½ days in a voyage of 3,000 miles is at all worth the cost at which it is attained. In some of the longer voyages now made by ocean steamers the waste is even greater than in the above estimate; and 50 or 60 tons of coal are consumed per hour, to carry 3,000 tons, although by compound engines a speed of 9 knots would be attainable with 14 tons, and a speed of 10½ knots with 20 tons.

The engines of the *Teniers* afford, perhaps, the latest example of the construction by which such economical steaming may be accomplished; and they occupy so much less space than those with which she was originally fitted that the change has in this way also, as well as in the smaller amount of coal stowage required, added considerably to her carrying capacity. They were built for Messrs. Lamport and Holt by Messrs. John Jones and Sons, of Liverpool, are provided with instantaneous starting and reversing gear, and with many modern improvements of detail which it does not fall within our province to describe.—*Times.*

THE IRON MANUFACTURE AT THE VIENNA EXHIBITION.

After the manufacture of pig-iron the next step towards utilising the products of blast furnaces was the conversion of the molten pig-iron directly from the blast furnace into castings of different forms and characters, or the previous remelting of the blast-furnace pigs in reverberatory, or cupola furnaces, before running the metal into the moulds. As the importance of the iron industry in general increased, and the dimensions and volumes of the manufactured articles became greater, castings, as a fundamental part of all iron constructions, necessarily gained in importance, and at the same time in volume and complexity.

We find an interesting testimony of the antiquity of this art in the Vienna Exhibition, where, amongst many objects of bronze found in the lake of Brienne, several moulds for bronze knives and other articles of the same material were exhibited, these belonging to a period far more than 2,000 years ago.

When the demand for iron castings increased, and their form and dimensions became more and more complex, great difficulty was encountered in finding skilled workmen and reliable foundry engineers, with sufficient knowledge and experience in moulding and casting, to carry on the business. Such was the necessary result of the exclusive character evinced by ironfounders in general, and at the same time the reason why only a relatively small number of foundries were in a position to carry out heavy and complicated castings. Now as science proceeds, the exclusiveness of this branch of iron industry is rapidly disappearing, and the progress shown in this particular manufacture proves the unrelenting diffusion of engineering knowledge.

Certainly, for some purposes, where an extra quality of iron is wanted, a monopoly will ever be held by a few foundries having at their disposition ores and pigs specially adapted for the purpose; but the general use of castings does not involve the necessity for the best qualities of iron, and it is precisely in this department where we see great progress made of late years.

We may divide the castings as exhibited in Vienna into four classes, not taking into consideration the "art casting" proper, as the latter do not form the subject of the present series of articles, wherein the metallurgical point of view principally will be maintained. We shall treat here, therefore, of:

1. Artificial castings with respect to dimensions, form, and general quality of products.

2. Castings where the production of large quantities in a specified time is the point aimed at.

3. Castings where strength of the material used is the principal object.

4. Malleable castings.

If we take into consideration the fact that the increased dimensions of the great number of metallic constructions has necessitated an appropriate increase of all cast-iron details, and that not only the weight and dimensions, but also the accuracy and nicety of the produced castings has been felt to be necessary, we are bound to acknowledge that the art of casting large and complicated piecework has made undeniable progress.

France always had the reputation of making the finest castings, owing to the exquisite moulding sand they have at their disposal. Next to France the most accurate and best castings are made in England, which is proved by the excellency of the cast-iron details furnished in all machines and tools. Creusot exhibits a steam cylinder for a marine engine, taken untouched from the mould, an excellent example of the performance of the foundry department. This cylinder has a diameter

of 0·96 metre, a stroke of 1 metre, and weighs 7 tons. It is the finest casting of this kind to be found in the Exhibition.

The Sociéte John Cockerill exhibited a large blowing engine of the Seraing type, the air cylinder of which is a good example of what these works can produce. This cylinder had a diameter of 3 metres and a stroke of 2·44 metres. Blansko, in Moravia, exhibited good examples of very complex castings, such as the valves of the water mains in Vienna. These mains had a diameter of 3 ft. and are tested to 15 atmospheres; the working pressure is 5 to 7 atmospheres. The valves had to be strengthened accordingly, and were changed several times before they stood the severe test. They were furnished with a number of ribs outside and inside, vertical as well as horizontal, thus making the valve-boxes a very complex and difficult casting.

Wheel castings have been made of a very interesting speciality, and America took the lead in this industrial branch. The iron used there is specially adapted to such castings, combining great strength with great hardness in the chilled portions of the wheel. The Royal Wheel Company, Cincinnati, and the Ramapo Wheel Foundry Company, Ramapo, New York, exhibited very good specimens of chilled cast-iron wheels. Besides the American exhibitors of cast-iron wheels, the latter were exhibited by the Arboga Works in Sweden, and by Count Andrassy, at the Dornö Works, in Upper Hungary, and by Ganz and Co., in Pesth. These two last exhibitors manufactured large quantities of such wheels, and in fact furnished all the cast-iron railway wheels running on the Austrian lines. These wheels consisted of two convex discs joined together by the centre and the tyre of the wheel, the whole being cast in one. Great care must be taken in the selection and mixture of iron to obtain the requisite chill on the tyre surface without straining the other parts of the wheel. These wheels have an average endurance of five years, after which time they must be recast. The cost of maintenance, including the cost for recasting, is about 4s. 7d. per year, as an average of ten years.

Besides these wheels chilled cast-iron crossings have come into extensive use. De Maré, of Ankarsrum, Sweden, exhibited a crossing which had been in constant use at Arwica, a very busy station of the Swedish States Railway, without showing any visible signs of deterioration. In the departments of France, Germany, and Austria we encountered several more exhibits of such chilled cast-iron crossings. A speciality of yet more confined manufacture is the production of chilled cast-iron rolls. It is to be deplored that England was not represented in this branch, which is a well-known speciality of English ironfounders. The Austrian States Railway and some iron manufacturers of Styria and Carinthia displayed numbers of these articles, but as these products only can be judged by the results obtained in working, it is difficult to express a preference for the one or the other of these exhibits by mere inspection of the metal, the

chill, and surface. The only firm which, according to long experience, has excelled in this sort of manufacture on the Continent, and which exhibits beautiful samples of chilled rolls for plates and different sorts of round and square bar iron, is the Royal Iron Manufactory at Konigsbrunn, Wurtemberg.

The last, but not the least, of the specialities in artificial castings we have to mention is the manufacture of anvil-blocks, which more than anything else show the constant increase in the dimensions and weights of manufactured articles.

Russia exhibited a model of one of the largest, if not *the* largest, anvil-blocks ever cast in one piece. This anvil-block, weighing 622 tons, was destined for the large 50-ton double-acting steam hammer of the Imperial Steel Works at Perm. To those who never had to do with such work the casting of an iron block of similar dimensions seems to be a easy task; yet nothing can be more exciting than the handling of large masses of molten iron, if we take into consideration the temperature of the liquid, the weight of the mass itself, and of the apparatus necessary for moving it, the rapidity with which all operations must be carried out to avoid the setting of the material, and lastly the loss in case of failure, it being nearly impossible to make any use of such a big block of metal.

The writer of the present lines having himself had occasion to superintend some such castings, of 50 and 100 tons respectively, is well able to judge of the difficulties in dealing with about 700 tons of molten iron. The plan adopted in one of the above named cases, and which we think is the best manner by which most of the difficulties may be overcome, was the following:—

Two large cupolas, with sufficient yield to finish the charges necessary for the casting within twelve hours, were set close to the pit and connected with a heating chamber expressly built for the purpose. This chamber was constructed of firebricks, and was about 8 ft. by 6 ft. and 5 ft. high. It was covered by a firebrick arched roof, and the whole structure was held together with strong iron plates and tie rods. The chamber was heated with coke the whole day previous to that on which the casting was to be made, and a red heat of the firebricks obtained, sufficient to keep the metal run into the chamber in a perfect liquid state for at least twelve hours. When the whole of the iron necessary was molten in the cupolas, and successively tapped into the heating chamber, the latter was tapped, and the iron allowed to run into the mould in a large and continuous stream. With this precaution a casting of perfect toughness and soundness was obtained.

Great care must be taken in preparing the mould for such large castings, and it has been found the best plan to divide the whole mould into several separate parts, which can be thoroughly dried in a drying stove, and are only replaced in the mould pit the day before casting. In this manner not alone the perfect dryness of the mould, but the principal condition for the production of a second casting, can be secured. The anvil-block exposed in model by the Russian Government is fitted, like all

modern anvil-blocks, with two trunnions, for the sake of facilitating the movement of the block.—*Abridged from Engineering.*

MR. HENRY COLE, C.B.

The Marquis of Westminister has presided, at Willis's Rooms, St. James's, over a very distinguished company of nobleman and gentlemen, many of whose names are closely associated with science and art.

The noble Chairman, in opening the proceedings, after speaking of the reasons which had led him to take the position he then held, entered upon a short statement of the public career of Mr. Cole, who, he said, entered the public service in 1823 under the Record Commission, and was instrumental in that reformation of the Record system of the country which led to the establishment of one general Record Office. In 1840 he gained one of the four 100*l*. prizes offered by the Treasury for suggestions for developing the penny postage plan of Sir Rowland Hill—a measure which he had assisted to carry. In 1850 and 1852 he drew up three Reports on "Reform of the Patent Laws," and so led to the reform in those laws—a work in which he was aided by Charles Dickens' paper entitled "A Poor Man's Tale of a Patent." In 1845 Mr. Cole originated the series of art manufactures designed to combine fine art with objects of utility. He also assisted to organize the Exhibitions of the Society of Arts, which he proposed should culminate every fifth year in a national exhibition of arts and manufactures—a proposal which was enlarged by Prince Albert into the Exhibition held in 1851, and of that Mr. Cole was one of the Executive Committee. Then Mr. Cole was British Commissioner at the Paris Exhibition in 1855, and carried out the work with a saving of 10,000*l*. on the Parliamentary vote. He was also secretary of the Royal Commission for the Paris Exhibition of 1867, when the expenditure, though great, was below the estimate made by Mr. Cole. The noble Marquis then went on to relate how Mr. Cole, on the invitation of Lord Granville for the Government, undertook the reformation of the School of Design established in 1837, and he had stated that he had witnessed the conversion since 1852 of 20 limp schools of design into 120 flourishing schools of art in the kingdom, and other schools like them had been established in the Colonies and United States. For artisans 500 night classes for drawing had been established, 180,000 boys and girls were now learning elementary drawing, and 1,250 schools and classes for science instruction had spontaneously sprung up. The South Kensington Museum had been recently founded as a national centre for consulting the best works of science and art, and of a storehouse for circulating objects of science and art throughout the kingdom. While the Museum had been visited by more than 12,000,000 visitors, it had circulated objects to 195 localities holding exhibitions, to which more than 4,000,000 local visitors had con-

tributed about 93,000*l*. The Chairman then mentioned Mr. *Cole's connection with musical education, and with the Albert Hall, and described the purchases he had made for the country; and what he had done might be said, the Chairman declared, to* have enriched the country by 500,000*l*. in the works of art which were now public property. The Marquis added that Mr. Cole had met with much opposition and hard words, but in spite of these he had steadily pursued his course. The happy results of his labours were now spread over England, Ireland, Scotland and Wales; and if the country was grateful for the services rendered, all classes would warmly support the proposal to mark Mr. Cole's retirement by aiding in presenting him with a national testimonial. (Cheers.)

Lord Houghton proposed the first resolution:—

"That it is desirable, on the retirement of Mr. H Cole, C.B., from the direction of the South Kensington Museum, to recognize in some permanent form his great services to the public."

The motion was seconded by Mr. Colin Campbell, and carried *nem. con.*

Lord Clarence Paget proposed a resolution inviting a public subscription, and this was seconded by Mr. George Godwin.

An aged gentleman, who said he was the son of an artist, desired to propose an amendment in effect the negative of the motion already carried, the speaker having the idea, as he had written to the Chairman, that he himself deserved the testimonial more than Mr. Cole, as being the originater of all Mr. Cole had carried out. The proposed amendment was ruled out of order and the original one carried.

The Duke of Sutherland proposed the names of the committee, which was seconded and carried.

The meeting was called by a provisional committee, who had signified their desire to promote a testimonal to Mr. H. Cole on his retirement from connection with the Science and Art Department of the Privy Council, "in recognition of his useful, energetic, and varied labours."

THE NEW ATLANTIC STEAMER "FARADAY."

This vessel has been built by Michell & Co. of Newcastle-on-Tyne, to the order of Messrs. Siemens Brothers, of London, for laying their Atlantic cables. The *Faraday* is 360 ft. long, 52ft. beam, 36ft. deep, and measures about 5,000 tons gross register. She will, however, carry about 6,000 tons dead weight. The iron hull has been built under the inspection of Lloyd's agents, and will be accorded the highest certificate of classification. In addition to the usual requirements of Lloyd's rules, the *Faraday* receives an enormous additional strength from her peculiar structure. This consists chiefly of three enormous cable tanks constructed of plate-iron, and forming a series of double arches supporting the sides of the vessel. These tanks are also united

together and to the general fabric of the hull by five iron decks; the upper and main iron decks are supplemented by the usual decks of wood for the comfort and convenience of those on board. This vessel is double-bottomed, the space between the two bottoms being a network of iron girders for carrying the cable tanks, and at the same time giving longitudinal strength to that portion of the hull. The space is further utilized for carrying water ballast to trim the vessel as the cable is run out, and also to enable her to make a voyage across the Atlentic without any cargo or other weight on board beyond fuel. A very complete and well-devised system of valves, cocks, pipes, and auxiliary engine-power, has been introduced into the vessel for filling and emptying any single compartment of the double bottom, or for flooding any one of the cable tanks. The whole system is under the control of the engineers, and is worked from the engine-room.

In outward appearance the *Faraday* is unlike other ocean steamers by her bow and stern being of the same form. She is also provided with a rudder at each end, the whole being so arranged that the vessel may be navigated ahead or astern as may be desired when paying out or picking up a cable. The steering is accomplished by means of a steam-engine placed amidships, and to provide against accident each rudder is supplied with strong screw steering gear worked in the usual manner by manual power. The anchors and cable chains are worked by Harfield's steam windlass, and all heavy labour about the vessel is performed by steam apparatus placed in various positions along the deck. The *Faraday* will be rigged in the most approved manner of ocean steamers, and for the accommodation of the large staff of officers, electricians, and crew, amounting to about 150 persons, the vessel will be fitted up with all the cabins and other appliances of a large passenger steamer, in addition to the multifarious applications of a cable ship.

The *Faraday* will be propelled by machinery on the compound surface-condensing principle manufactured by T. Clark & Co., of Newcastle. There will be two distinct sets of engines, each working a separate screw, the vessel being thus provided with two propellers, usually called twin screws. The object of this arrangement is to obtain increased steering or manœuvring power, which is a very important condition in cable-laying. Each set of engines is placed vertically over the shaft and has two cylinders, one high pressure and the other low pressure, by which great regularity of motion is obtained, and by a high degree of expansion in working the system an important economy of fuel is effected. By these means this great vessel is enabled to carry her immense burden of cable at an expenditure of fuel which would have seemed impracticable but a very few years ago. The deck machinery required for paying out and picking up cables is being manufactured by the Vulcan Foundry Company, who have had great experience in this kind of work.—*Times*.

DYNAMITE.

Dynamite, which is gradually superseding the use of gunpowder in many of the mining districts of Glamorganshire, has been subjected to some tests at Clyneu Colliery, the property of the Newport and Abercarn Black Vein Steam Coal Company. The experiments were made with the view of dispelling the prejudice which has hitherto impeded the introduction of this explosive in the mining districts of Monmouthshire. The experiments were conducted by Mr. S. Thompson, from the British Dynamite Company, of Glasgow, aided by Mr. A. Widdowson, the agent for the district; and they certainly afforded, to all who witnessed them, a satisfactory illustration of the valuable characteristics of this explosive force. *The powder was first tested in a shaft. Charges of 16 oz. were inserted in five holes, varying in depth from 2 ft. to 3 ft.; and the total amount of Dynamite thus brought into requisition represented the explosive power of 6 lb. of No. 2 blasting powder.* The result certainly far exceeded that which could have been produced by a proportionate amount of the material ordinarily used, and the miners seemed to be highly satisfied with the experiment, especially remarking on the almost entire absence of smoke after the explosion. Indeed the rapidity with which the gases evolved from this powder evaporate constitutes one of its primary advantages, for the men are thus enabled to resume work immediately.

M. Cailleaux has presented to the Society of Civil Engineers a paper on Dynamite, which is remarkable for the ability and clearness with which the subject is discussed.

The author first gave an historical sketch of the improvements realised in the manufacture of explosives; concluding by a special notice of the subject of his paper. He described its now well-known properties, alluded to the safety with which it may be transported, stored, and used, and noticed the services it had already rendered to industry in public works and in mining operations. France has paid to foreign countries during the last three years:

111,000,000	francs for	silver
73,000,000	„	copper
45,000,000	„	lead
58,000,000	„	zinc
29,000,000	„	tin

or almost 360,000,000 francs; whilst the home mineral production is now almost insignificant. Now steam, compressed air, and Dynamite, the three great aids the art of mining has received, would easily produce the enormous mineral wealth of France, now neglected.

M. Cailleaux then examined the actual position of Dynamite in relation to the State, which possesses the exclusive privilege of manufacturing powder, and he argued that the tax levied is

prohibitive. In his opinion, if the State alone possessed the right of manufacturing Dynamite, all chances of introducing and working it in France would be ended. He completed his paper by expressing the following wish:

'Considering the ever increasing requirements of industry, and the constantly increasing price of hand labour, which renders the use of powerful energetic agents more and more necessary, he desired that explosive agents other than powder, properly called, should be freely manufactured and sold. That they should be subjected only to the regulations which rule in other countries. That the duty upon the Dynamite should not sensibly raise the price above that charged in other countries, viz.,

5	francs	the kilogramme in	England
5	,,	,,	Sweden
3·75	,,	,,	Germany

The following trial has been made in the tunnel on the Halifax and Ovenden Junction Railway. The experiments were made by Mr. Edwards, of Newcastle, agent for the Dynamite Company, under the superintendence of Mr. R. E. Cooper, C.E., the resident engineer of the line. The rock in which the Dynamite was used is the hardest found in the district. The mode of using the Dynamite is extremely simple. It is made into cartridges varying from 2 in. to 6 in. in length, and from ½ in. to 1½ in. in diameter; a percussion-cap, very similar to an ordinary gun-cap, is fixed to the end of the fuse; the cartridge having been opened at one end, the cap is pressed into the Dynamite and secured there by ordinary twine. The cartridge having been placed in the borehole and tamped with water or sand, the fuse ignites the cap and the explosion of the cap explodes the Dynamite. The first experiments were intended to show its effect as compared with powder, and from these it was calculated that a cartridge 5 in. long and ¾ in. diameter, containing 3 oz. of Dynamite (which was the largest used on that day) has as much disruptive effect as 1 lb. of powder. Next, three cartridges, each containing 3 oz. of Dynamite, were placed on a block of stone 4ft. square and 3 ft. thick, and covered with a shovelful of wet sand. On being exploded it was found that the rock was split completely through into four pieces. Thirdly, in order to show that there was no danger from the Dynamite taking fire when in small quantities, a cartridge was ignited, and Mr. Cooper held it in his hand whilst it burnt away with a steady flame, no explosion whatever occurring. It was proposed to have several more trials, so as thoroughly to test its qualities, and if considered successful for practical purposes it would in all probability be used altogether for the mining work of the tunnel. It was expected that a saving of 50 per cent. in time would be effected by its use.—*Halifax Courier.*

DYNAMITE, LITHOFRACTEUR, AND GUN-COTTON.

A DISCUSSION at the Institution of Civil Engineers on explosive substances seems to establish the comparative safety, force, and economy of Dynamite and Lithofracteur as against Guncotton; and at a meeting of the East Worcester Institute of Mining Engineers, held at Dudley, an experiment was reported on which seems to illustrate the efficacy of Dynamite in overcoming great resistances. A large mass of cast-iron, resulting from the leakage through the bottom of an iron smelting-furnace, had on several occasions been subjected to the action of gunpowder to break it up without success. The mass was about 8 ft. thick, and a number of cartridges of Dynamite were introduced into one of the old chambers which had been made when it was tried to burst the mass by gunpowder. The result was to shatter the block into pieces, some of which were projected to a considerable distance from the spot. The opinion generally arrived at by the persons present was that for blasting purposes Dynamite was preferable to gunpowder, especially in wet ground, where gunpowder cannot be used; and, as it is also preferable to Guncotton, it appears to be the best blasting material we have now at our disposal.

THE GUNPOWDER PILE-DRIVER.

AMONG the many useful improvements introduced of late years in connection with labour-saving apparatus for engineering construction may certainly be classed the Gunpowder Pile-Driver of Messrs. Shaw and Justice, brought out originally in the United States, introduced into England some five years since. The apparatus consists of an ordinary pile-driving engine having a ram, from the upper and underside of which a plunger projects. The ram is fitted with an arrangement by which it may be retained at any desired height above the pile-head. A cast-iron cap, having a hole in its centre into which the lower plunger of the ram will fit, is placed on the top of the pile to be driven, and in the hole is inserted a small charge of gunpowder. On the ram being released, the lower plunger enters the hole in the cap, and compressing the air within, generates heat, which ignites the gunpowder. The force of the explosion is utilised partly in driving the pile downwards, and partly in throwing the ram upwards, the latter being detained at the required height ready for the next blow. Should the ram be thrown too high, the upper plunger enters an air cylinder, compressing the air and cushioning the blow. The charges of gunpowder were at first fed into the cap-piece by hand, but a self-acting feeding arrangement was afterwards added which, still further simplifies its operation. A very fair idea of the performance of these machines on a practical scale may be gathered from the report of the United States engineers upon some work done in the new Navy Yard, League Island. About 400 piles were driven

mainly from a scow or barge on which the apparatus was erected. Very low tides, severe cold, heavy ice, and sunken rocks, rendered the work of driving somewhat difficult; but notwithstanding this, the result was that the 400 piles, averaging over 30 ft. in length and 10 in. in diameter, were driven an average depth of 21 ft. each in an average time of 13½ minutes per pile, inclusive of moving the barge into position. The average number of blows to each pile was 8½, and the average distance to each blow was 2 ft. 6 in. The piles were driven without rings, shoes, or points, each pile being cut off square at top and bottom, but not one is reported to have been split or splintered. The charges used were 1 and 1¼ oz. of common blasting powder compressed into cylindrical blocks, and rendered non-explosive except at high temperatures. The results show that the desideratum of preserving each pile solid and unshattered is attained by the Gunpowder Driver.—*Engineering.*

KYANISING.

The old process of preserving wood by Kyanising has gone very much out of use; and, as applied to ship-building purposes, it was no doubt objectionable, as, besides being expensive, the preservative material, which was corrosive sublimate, corroded the iron bolts driven into the wood. The preservative action, however, was found to be very effectual; and the albumen of the wood, in which the decay usually begins, was coagulated and rendered inert. In America some experiments have lately been made to contrast the durability of kyanised wood with wood used in its natural state. Logs 9 in. square and 18 ft. long, of various native woods, were cut through longitudinally, and one half of each was kyanised, and the other half left without any preparation. The whole were then erected as posts in 1863. When examined during the past year, the kyanised halves showed scarcely any signs of decay, while all the unprepared specimens were very much decayed—in some cases so much so as to have broken down.—*J. C. Bourne, C.E., Illustrated London News.*

THE PRESERVATION OF TIMBER.

We have lately had an opportunity of examining some specimens of timber preserved by a new and very promising process, invented by Mr. J. B. Blythe, of Bordeaux. Mr. Blythe treats the timber with carburetted steam—that is, with steam having mixed with it a small proportion of hydrocarbon vapour—the result being an evolution of acetic acid, and the formation between the fibres of the wood of a peculiar gummy substance, which hardens by time, and which appears to materially increase the resisting powers of the material. When first treated the timber is so softened that it can be rolled to give it an even surface, or its form can be altered to a considerable extent by pres-

sure, and it can thus be moulded to many forms, which are at present only producible by the action of cutting tools. The forms thus given to the timber in a soft state are retained permanently. As far as can be judged from experience gained on the Northern Railway of France, on which line sleepers, treated by this process, have been down for some time, Mr. Blythe's system of treatment is an effectual preservative, while it has the great advantage of enabling green timber to be seasoned in a few hours. In fact, the sap wood, when "carburetted," appears practically equal to the heart wood in durability and powers of resistance.

DRAINAGE WORKS IN HOLLAND.

The commissioners appointed for the erection of steam drainage works in the Zuilichen (Bommelerward) Marsh or Polder, beg us, for the sake of those who are interested in such works, to insert the following: "After a long investigation and discussion it was decided to erect in the Zuilichen Polder direct-acting centrifugal pumping machinery, from Messrs. Gwynne and Co., engineers (Essex-street Works), London, instead of the present or former steam-engine. The direct-acting pumping-engine was to be of 20 horse power, provided with condensation and expansion arrangements, and the pump with syphon pipes, serving to give a larger discharge when the lift was lower. The Polder, which contains about 500 nects (about 1,400 acres of land), and was covered with water, was pumped dry in 26 days and nights (24 hours each). The outer sluices were shut, in order to try the pumping power. The results were such as to surpass all expectations. It showed that—at lifts of 1·50, at 1·65, at 1·75, and at 2 metres—every minute there was discharged a greater quantity of water than the quantity contracted for by Mr. C. Bak, of Dolfshaven, agent for Messrs. Gwynne and Co., of London. The trials could not go further, because the water in the canal could not be raised higher. The commissioners intend to raise the canal 1 metre, in order to lift the water from the Polder to a relative higher state as compared with the level of the water in the river. (The machine is a combined engine and centrifugal pump with delivery pipes 18 in. diameter, and was designed to discharge 6,000 gallons per minute at an elevation of 3 metres, running 180 revolutions. It has a cylinder 14 in. diameter × 10 in. stroke, and works with 52 lb. of steam in the boiler, steam being cut off at one-quarter of stroke. The condenser is one of the ordinary injector condensers with ram plunger, and produces a vacuum of 27½ in. The coal used was 2½ kilogrammes per horse power per hour in water lift, which is a very excellent result). The simple arrangement of the pumping machinery is most satisfactory, as well as the neat, useful, and practical way in which it is finished, the excellence of its working, and its high useful effect."—*Engineering*.

TUBE WELLS.

A. M. DONNET has brought before the world a modification of the Norton tube well. The *Bulletin de la Société d'Encouragement* (March 1873) contains a description of this system, on which M. Tresca has reported very favourably. "M. Donnet," he says, "has performed a useful work in constructing this apparatus, and he will do a yet more useful thing in extending its introduction."

In M. Donnet's machine the sinking of the tube is effected by means of a falling weight, weighing from 200 to 250 lb. The tube is made up of several lengths, in the foot of which there are small holes, and below these holes a steel point to aid in penetrating the ground. The tubes are coupled by sleeves. The falling weight runs in guides on a vertical frame, and the tube also passes through appropriate guides. The whole system can be mounted on a carriage for transport.—*Engineering.*

MACHINES, TUNNELS, AND MODELS.

MR. ARCHIBALD NEILL has described to the Mechanical Section of the British Association the stone-dressing machinery employed at his works in Bradford, stating that for several years he could not dispose of a single machine-dressed stone in Bradford, owing to the inimical attitude of the masons; but now all opposition had ceased, and he had the hearty co-operation of all engaged in the building trade.

The St. Gothard Tunnel was described by M. Bergeron, of Lausanne. The contractors for these works are under heavy penalties to complete them in eight years, and the length of the tunnel is two miles longer than that of Mont Cenis. The boring drills are those of Dubois and François, worked by compressed air at five atmospheres, and the blasting is performed by dynamite.

Mr. White, of Cowes, the well-known ship-builder, exhibited a beautiful model of a vessel proposed by him for the service of the Channel passage. In lieu of a convex form for the bottom a concave one was adopted, and this, he believed, would counteract the tendency to roll.

Italian irrigation was then brought before the Section, in a paper by Mr. P. Le Neve Foster, jun., descriptive of works intended to serve the district of Casale, in Piedmont, where the author has been engaged for several years on undertakings of this character. The works in question consist principally of a canal, by means of which the waters of the Po will be made available for fertilizing a large and otherwise comparatively non-productive district of land. For these plains water is, as it were, the life-blood of the country, and for many years past such works have been the study of Italian engineers.

HYDRAULIC AUTOMOTOR: PUMPS SUPERSEDED.

The wonders of the hydraulic press have prepared one for other extraordinary manifestations of working power in this direction; and we now observe, from an elaborate article in the *Mining Journal*, with drawings of mechanism in illustration, that a "Hydraulic Automotor" has been invented (though not yet in practical use) which, it is expected, will altogether supersede the use of pumps for raising water, whether from mines or for *any other purpose. This important idea in connection with practical hydraulics is claimed by Dr. Bourbon des Clayes, of* Paris. It is evident that, if whilst retaining, or nearly so, the proportional relations between the power and the resistance of the hydraulic press, we could succeed in augmenting in a notable proportion its conditions of speed, we should have a motor at once the most powerful, the most economic, and the least dangerous in use which could be placed at the disposal of mankind. It is precisely of this problem that the Hydraulic Automotor is claimed to be the solution, and of which a theoretical and practical demonstration is offered.—*Builder.*

COMMUNICATION WITH DIVERS.

An interesting series of experiments has been carried out in the Medway, off Chatham Dockyard, by the officers and men of the Royal Engineers, under the direction of Major E. D. Malcolm, the head of the Torpedo Department of the School of Military Engineering, for the purpose of testing the merits of an invention by Mr. Mauldin Vinter, for enabling divers, when employed at any depth, to hold conversation with those at the surface of the water. Hitherto, an insuperable difficulty has been experienced by divers in being unable to communicate verbally with the attendants above, the principle usually adopted by divers when carrying on their operations being to give preconcerted signals by so many pulls on a signal line. This, however, appears to have been at length overcome by Mr. Vinter, in the invention submitted by him to the Government. In the trials just completed in Chatham Harbour, Corporal Falconer, an experienced diver of the Royal Engineers, equipped in the Siebe and Gorman improved diving apparatus (which has gained the prize medal at Vienna), made the descent, and during the whole time he was under water was enabled, by means of the new apparatus, to converse freely with those above, every word spoken by him being distinctly heard and understood. Mr. Gorman, who was present during the experimental trials, stated that the invention would be further improved upon, so as to facilitate its use in all diving operations connected with harbour works, and for laying stone blocks, &c., in connexion wtih subaqueous operations. The apparatus can, it is stated, be easily applied to any description of diving dress. The value of the invention will be readily understood and appreciated by

every one interested in the science of diving, from the simple fact of the great confidence a diver will gain from being, in his isolated position, enabled to speak directly to those in whose hands his life, for the time being, is literally placed.—*Engineering.*

NEW ARTIFICIAL STONE.

THE *Journal* of the Franklin Institute informs us that Mr. Frederick Ransome read, on November 10, a paper before the Institute "On Some Recent Improvements in the Manufacture of Artificial Stone," and especially of a new and improved variety of it, to which the name of Apænite has been given.

BRICK-MAKING.

MR. WHYMPER, Sub-Inspector of Factories, is able to report that the application of the Factory Acts to the Kentish and other brickfields under his inspection has been successful. It had been objected that long hours must be worked in fine weather to make up for stoppages in wet weather; but these frantic efforts of 15 or 16 hours' work were not required to make up for bad weather alone, but for wanton idleness and for time wasted in drinking. Mr. Whymper says:—"The quantity of beer consumed by 'brickies' is almost incredible. One master has allowed ten pints of beer a day to each 'setter.' Carts laden with beer regularly make the rounds of some fields. Many of the master brickmakers were, and still are, publicans. Some even have publichouses in their own fields. I remember myself, on a brilliant day of last summer driving into a field where I expected that all would be busily at work. Nobody was at work at all; but at the door of the publichouse, in semi-drunken conversation with the portly gentleman, who was brick-master and publican in one, lounged three or four stalwart brickies. On my appearance they transferred their attention to myself and my horse. Clasping the neck of the latter, or leaning on the shafts, they assured me with a tearful pertinacity that we (I presume they included the horse) were 'all of the same flesh and blood,' an observation which, though relevant to nothing in particular, seemed to afford them the liveliest satisfaction. They did not think it due to their pockets to work every fine day, nor did their employers show any signs of objecting to their relaxation." Mr. Whymper is able, however, to add that from all quarters he hears now of the diminution of drunkenness under the operation of the Factory Act; one of his informants declares that it has been lessened by two-thirds. The men are said to be becoming less rough, less coarse in their amusements, and, in a word, more respectable. The clauses for the protection of children are almost universally approved. A manager of important works states that he, while under nine years of age, and working from 5 A.M. to 9 P.M., lifted 45,000 bricks per week,

each brick weighing about 10 lb.; he frequently had to be carried home exhausted on the moulder's back. Another narrator mentions having frequently fallen asleep over his supper, and been roused next morning with the food still in his hand; and the foreman of his field, a Roman Catholic, often fell asleep while saying his prayers at night, and was found next morning lying by the side of the bed. But now the brick children, half-timers, are regular in their attendance at school, and very orderly pupils; young girls go to domestic service who would formerly have been in the brickfield; and even those masters who maintain that production has decreased, willingly, for the most part, accept the restrictions on account of the regularity which they necessitate. Mr. Whymper adds that it should be borne in mind that legislation can only give people the opportunity of becoming good and healthy; how far they will avail themselves of it depends largely upon those with whom they associate, and upon those whose judgment they respect—an important consideration for magistrates, clergymen, inspectors, surgeons, and also for tradesman and cottager, each in his station.—*Times.*

GRANITE, ASPHALTE, OR WOOD.

Mr. William Haywood, the engineer to the City Commission of Sewers, who has at much length reported to that Commission on street paving in the City, states in that report that the observations taken were, first, of the traffic—the number of horses and vehicles which passed through the selected streets; and, secondly, of the accidents which occurred to the horses. We have not space to quote Mr. Haywood's details *in extenso.*

The result of the observations went to prove that asphalte was most slippery when merely damp, and safest when perfectly dry; that a horse might be expected to travel on the asphalte without an accident nearly twice the distance when the pavement was dry that it could do when damp, and that the difference between the safety of asphalte when wet and dry was not considerable. The granite was most slippery when dry and safest when wet; a horse might be expected to travel on granite without accident nearly seven times the distance when the pavement was wet than when dry, and the granite was about twice as safe when merely damp as when dry. Wood was most slippery when damp and safest when dry; a horse might be expected to travel on the wood more than three times the distance when the pavement was dry than when damp, and wood was more than twice as safe when wet as when damp.

A QUEENSLAND BORING MACHINE.

At the stores of Messrs. P. N. Russell and Co., Brisbane, a Boring Machine has been exhibited, which has attracted some interest. The machine has been constructed for Mr. R. Austin,

the proprietor of several tin properties at Stanthorpe, and it is to be used by him in prospecting the ground for lodes. The machine consists of a hollow tube, about 4 ft. long and 3½ in. diameter. This works on the augur principle, and sinks through any kind of ground rapidly. To this is attached a length of stout iron rod, and the machine can be made to sink any depth by the screwing on of additional lengths, the means for which are provided. The borer is worked by means of a stout beam of wood, which is inserted in an iron ring at the top, and the labour of one or two men is all that is required. Working in hard ground, it takes about 15 minutes to fill the borer, which is then taken out, cleared of its contents, and re-inserted. To keep the hole free from water, there is a suck-pump, which is screwed on instead of the borer, and rapidly empties the sinking. There is also a jumper for getting through rock.—*Engineering*.

BALTIMORE BRIDGE COMPANY.

THIS Company has, since its organisation, built over 100 bridges and viaducts, measuring in length upwards of 9 miles, and containing 13,000 tons of steel and iron, in addition to several million cubic feet of timber and masonry. The Company's list of bridges comprises one draw span 366 ft. long, and one viaduct in South America which is said to be the highest in the world. Details as to this viaduct, which occurs on one of the Peruvian railways, have been given in *Engineering*.

THE LONDON WATER COMPANIES.—CONSTANT SUPPLY.

THE following extracts are taken from the Report of Mr. Frank Bolton, Water Examiner, on the new works undertaken by the different London Companies, with a view to give a constant supply to their districts:—"The construction of additional subsiding and impounding reservoirs by the Chelsea, Grand Junction, and Southwark and Vauxhall Companies, is most desirable. The Kent Company, in accordance with the notice given in January last, have completed the arrangements for and are now giving constant supply to about 1,500 houses in their district, situated in the parishes of St. Mary's Rotherhithe and St. Paul's and St. Nicholas, Deptford, and have applied to the Metropolittn Board of Works, in conformity with sec. 34 of the Metropolitan Water Act, 1871, for instructions for affixing hydrants to the mains in the district now under constant supply. The New River Company have now the power of affording effective constant service in their district. They have also commenced a new high service covered reservoir, to contain 1,000,000 gallons, at Southgate, in anticipation of the requirements of the water supply to Edmonton parish. The Company have in a number of cases afforded constant supply by means of standpipes, and have recently agreed with a committee of the Corporation of the City of London to furnish constant supply at once to a large number of the houses of the poor within the City bounds, when-

ever the arrangements of the officers of the Corporation in connection therewith are completed. The East London Company are extending the constant system of supply in their district, and have completed the arrangements for supplying the 6,328 houses in the special district referred to in previous returns. The Southwark and Vauxhall Company are constructing covered service reservoirs at Nunhead, to contain 18.000,000 gallons, and are erecting additional engine power for high pressure constant supply. Additional boilers and works are also being constructed at Hampton. The West Middlesex Company are giving constant supply to a number of houses on the application of the owners, who have provided fittings according to the Board of Trade Regulations of the 10th August, 1872, and are fully prepered to extend the constant supply when called upon. This company are also constructing extensive works and additional engine power at Hammersmith and at Hampton, to insure effective supply. The Grand Junction Company have completed a high service reservoir near Kilburn, to contain 6,000,000 gallons for constant supply, and are now laying a line of main pipes to connect up this reservoir with the works at Campden-hill, and are likewise erecting additional boilers and works at Hampton. During the time these works are in progress the filtration is inefficient, but every effort is being made to complete the works as soon as possible. The Company are also giving constant supply by means of standpipes in a number of courts and alleys, and arrangements have been made to supply upwards of 5,000 houses of this class. The alterations in fittings under the new Board of Trade Rules and Regulations are being gradually effected as occasion offers, and are carried out in all new buildings. The Chelsea Company are proceeding rapidly with the construction of the new filter-beds at Ditton. One of about one acre area is already completed, and another nearly so. A considerable improvement in the filtration of this company should shortly be effected."

DOMESTIC WATER SUPPLY.

MR. JABEZ HOGG, M.R.C.S., writes from Bedford Square to the *Times*, July 10:—"While the Local Government Board, through its officer of health, is very properly directing public attention to the extreme regard for the use of pure water, and advising the heads of households to see 'to the sources and character of the domestic water supply, and the regular removal of refuse,' and so forth, as a means of preventing the spread of cholera, it does appear that another department of the Government entirely ignores this important question and its duty to the public in the matter of a water supply entirely under its control. I beg, therefore, you will allow me to direct attention to the very disgraceful and contaminated state of the water in the Trafalgar Square fountain basins at the present moment. During the mid-day heat the water positively emits a perceptibly

disagreeable odour, and some of the green water which I submitted to a microscopic examination the other day was loaded with organic matters, animal and vegetable life, &c. If this water finds its way into any of the public offices, I pity the people who make use of it; and I also feel a certain amount of alarm for the dirty little boys who sit on the edge of the basin, washing their black feet in it, and bailing out quantities in their hats and shoes for the purpose of allaying thirst."

NEW REFRIGERATING APPARATUS.

A PARTY of gentlemen attended at the factory of Messrs. Siebe and West, Mason Street, Westminster Road, in order to witness the working of an Ether Refrigerating Apparatus, which Captain Frederic Warren, R.N., the inventor of the well-known "cooking-pot," proposes to apply to many useful purposes. The apparatus consists of a small steam-engine, to which is attached a second cylinder for condensing ether vapour. The cold produced by the expansion of condensed ether is utilised by being communicated to brine contained in pipes around which the ether circulates. The brine thus cooled is used in its turn either to freeze water or to cool air, the water being contained in reservoirs immersed in a vessel of cold brine and the air being conveyed in pipes, which wind backwards and forwards in such a vessel. The ether employed, being contained entirely in closed apparatus, is scarcely at all wasted, and little more than its first cost need be taken into account. In the above experiments the moisture on the outside of the pipes leading to the refrigerator was rapidly frozen; and the air of the room, after being withdrawn at a temperature of 62 deg., was almost immediately returned into it at 45 deg.; while, as this process continued, the temperature of the room was rapidly reduced, and might easily have been brought to the freezing point and so maintained. Captain Warren claims that the temperature of any limited space can thus be kept down to almost any required degree; and he proposes to apply the method to the construction of cold chambers on board of ships, to be used for storing fresh provisions, or, in the case of merchant ships, for the conveyance of perishable freight. Thus he would have a cold chamber for bringing dead meat, say, from Aberdeen to London, and would accomplish this at a very small expense; but he does not think it possible to freeze a whole cargo of dead meat, so as to obviate internal putrefaction during the long voyage from Australia. He proposes, however, to cool railway carriages in hot climates, to provide cool vans for the conveyance of dead meat and other provisions in India, to cool the air admitted into hospital wards in hot climates, and to provide an unlimited supply of pure ice at almost nominal cost. Messrs. Siebe and West have prepared the necessary machines for all these purposes; and among the visitors yesterday were some officials from the Admiralty, come

to examine into the matter with reference to its applicability to the wants of the Navy. Captain Warren asserts that one of his cool chambers would allow a man-of-war to carry a month's supply of fresh meat and vegetables for her whole company; and if this be so, it would be scarcely possible to confer a greater boon upon the service.—*Times.*

WATER-GLASS.

By a paper recently read before the French Academy, it appears that silicate of soda, or Water-Glass, hinders, like borax, the manifestation of the organisms which produce putrefaction, but its action is more energetic than that of borax. The substance, it is concluded, is likely to find a wide application in destroying the infectious germs to which a number of diseases is to be traced.

OIL OF VITRIOL.—"STONE OF VITRIOL."

The oil of vitriol, or mixture of anhydrous sulphuric acid with its first hydrate—so-called Nordhausen sulphuric acid—is now very seldom manufactured, as the production of the ordinary hydrate, or English acid, is far more economical, and suits almost all purposes. It appears that the manufacture of the former is still principally going on in Bohemia, at the works of Von Starcu, where large quantities of iron pyrites are transformed into so-called "stone of vitriol," from which the oil of vitriol is derived by distillation in clay retorts. These vitriol works are at Davidsthal, Bikov, Kasnau, Bras, and Branovic, and they appear to produce annually something like 1,500 tons of oil of vitriol. With regard to the yield, it is of importance how the stone of vitriol is composed, and it is best if it consists entirely of "ferrisulphate"—that is, anhydrous sulphate of oxide of iron, instead of ferrosulphate, or anhydrous sulphate of protoxide of iron. The more of the latter it contains the greater is the loss of oil of vitriol through its decomposition into sulphurous acid and oxygen, the latter combining with the protoxide of iron. E. V. Tahn, of Pardubitz, the manager of Von Starcu's works, lays the greatest stress upon freeing the sulphates of iron from protoxide, and upon producing a thorough "ferrisulphate" before subjecting the stone of vitriol to the process of distillation.—*Engineering.*

THE NEW HARBOUR WORKS AT JERSEY.—LITHOFRACTEUR.

The long-felt want of better and more extensive harbour accommodation at Jersey is in course of being supplied by the extensive works now being carried out at St. Helier's by Sir John Coode. They comprise breakwaters, piers, and landing-stages, which will enclose a large water area in the Little Roads, and will afford berthage for the largest steam vessels frequenting the port of St. Helier's at all states of the tide, as well as safe anchorage and shelter for any amount of shipping. The

open space between the mainland and Elizabeth Castle will be partially traversed by a breakwater, whilst another breakwater will be continued out seawards from the latter point for a distance of about 2,700 ft. On the other or eastern side, a roadway will be made from the present Victoria Pier to a point below the Engineer Barracks, whence it will be continued seawards for 1,400 ft.; there it will turn westward by a curved piece, 300 ft. in length, terminating 1,400 ft. from the latter point in a fine pier and landing-place, with low-water berths for steamers. The evil of landing and embarking passengers at low water by means of small boats will thus be avoided, and the harbour will never be dry, as the present one always is when the tide is out. But before this can be effected, a vast amount of blasting and quarrying will have to be done, both for clearing a route for the breakwater and piers, and for levelling the bottom of the new harbour. Much has already been done by the aid of gunpowder, but the work has been slow owing to the peculiar character of the rock, which is a hard tough syenite, in which broad bands of trap rock occur at frequent intervals. The engineer of the works, Sir John Coode, has therefore been for some time past desiring to obtain an explosive agent which would have a better effect than gunpowder on the refractory material with which he had to deal, and which would, moreover, be suitable for subaqueous operations.

The lithofracteur of Messrs. Krebs and Co., of Cologne, was the explosive selected for trial, and some experiments on a working scale were recently carried out in the harbour by Herr Engels and Mr. Perry F. Nursey, with the view of demonstrating the applicability of lithofracteur to the purpose. Operations were commenced by an attack on a mass of rock of irregular shape, about 45 ft. in length, 18 ft. in width, and about the same depth, situated in front of the Hermitage. Here several holes were bored, and charged with lithofracteur, small charges being also placed in vertical crevices in the rock, and the whole fired simultaneously. The result was, that after several such blasts, involving an expenditure of 13 lb. of the explosive, the rock was considerably reduced in bulk, and the remaining portion so shattered as to make easy work for the quarrymen.

Numerous other trials were made, including one with a 50 lb. box of lithofracteur, which was lodged against a jutting crag about 16 ft. long, 8 ft. wide, and 6 ft. high, and attached to a mass of rock at one end. The charge was simply placed in a deal case, and laid at low water by the side of the rock with heavy stones placed upon it to keep it down. When the tide had risen 6 ft. the charge was fired, throwing a fine column of water high into the air, and demolishing the wall of rock. The body of water projected upwards of course represented so much non-paying work done, and had there been a wall of rock on each side of the charge the energy expended in producing the column of water would have been utilised in doing profitable

work. As it was, however, the engineer of the works expressed himself satisfied with the results.

The most valuable experiment, perhaps, was the demolition of a large wall of rock with a heavy submarine charge of lithofracteur. Standing out in the fairway of the harbour is a large mass of rock, some 40 ft. or 50 ft. high, on one side of which was a vertical opening, wedge-shape in plan, 6 ft. wide at the outer or seaward end, and only a few inches at the inner end. On the one side was the main rock, and on the other a wall of rock 20 ft. high, 19 ft. long, and 12 ft. thick. At the back of this crevice, on the rocky bottom, were placed at low water two 50-lb. boxes of lithofracteur, and on to these was tied an exploding charge of 10 lb. of the same material, in which were inserted two capped fuses, which were led up to the top of the rock. The charge was well secured to protect it from the scouring action of the waves, and the tide was allowed to rise over it. At 9 o'clock the same night, the tide being at the full, and giving a head of some 12 ft. or 14 ft. over the charge, an attempt was made to land on the rock and fire the charge. The weather, however, was rough, and there was a heavy sea on, which rendered the attempt to land futile. The following day being Sunday, the charge was left to itself to weather two more heavy tides. At high water on Monday morning a landing was effected and the fuses lighted, but no explosion followed. At low water inspection showed that the wind and waves had caused the fuses—which were secured at intervals—to rub and chafe against the rocks, so that they had both become damaged and useless about 6 ft. from the charge. A 5-lb bursting charge was therefore made fast to the main charge, and two more fuses led up to the rock in such a manner as to render damage impossible. At high water the same night a landing was effected, the fuses fired, and the charge exploded with very satisfactory results, the whole of the wall being completely removed. Taking the dimensions of this wall at 20 ft. by 19 ft. by 12 ft., as already stated, gives a cubical content of 4,560 cubic feet, or 169 cubic yards. The rock weighs 2 tons per cubic yard, so that we have in round numbers 340 tons removed by a charge of 115 lb. of lithofracteur. The experiment proved, moreover, that the full power of this explosive was developed, although it had been subject to the action of wind and waves for 55 hours, and to that of five heavy tides. The result of these experiments is the fact that Sir John Coode has decided to use lithofracteur in carrying out these extensive and important works.—*Engineering*.

THE CHANNEL TUNNEL.

At a meeting of the Institution of Civil Engineers, a paper has been read "On the Geological Conditions Affecting the construction of a Tunnel between England and France," by Mr. Joseph Prestwich, F.R.S.

The author, in this paper, reviewed the geological conditions of all the strata between Harwich and Hastings on one side of the Channel, and between Ostend and St. Valery on the other side, with a view to serve as data for any future projects of tunnelling, and to show in what directions inquiries should be made. The points considered were the lithological characters, dimensions, range, and probable depth of the several formations. The London clay, at the mouth of the Thames, was from 200 ft. to 400 ft. thick, while under Calais it was only 10 ft., at Dunkirk it exceeded 264 ft., and at Ostend it was 448 ft. thick. He considered that a trough of London clay from 300 ft. to 400 ft., or more, in thickness, extended from the coast of Essex to the coast of France, and, judging from the experience gained in the Tower Subway, and the known impermeability and homogeneity of this formation, he saw no difficulty, from a merely geological point of view, in the construction of a tunnel, but for the extreme distance—the nearest suitable points being 80 miles apart. The lower tertiary strata were too unimportant and too permeable for tunnel work. The chalk in this area was from 400 ft. to 1,000 ft. thick; the upper beds were soft and permeable, but the lower beds were so argillaceous and compact as to be comparatively impermeable. In fact, in the Hainaut coalfields they effectually shut out the water of the water-bearing tertiary strata from the underlying coal-measures. Still, the author did not consider even the lower chalk suited for tunnel work, owing to its liability to fissures, imperfect impermeability, and exposure in the Channel. The gault was homogeneous and impermeable, but near Folkestone it was only 130 ft. thick, reduced to 40 ft. at Wissant, so that a tunnel would hardly be feasible. The lower green-sands, 260 ft. thick at Sandgate, thinned off to 50 ft. or 60 ft. at Wissant, and were all far too permeable for any tunnel work. Again, the Wealden strata, 1,200 ft. thick in Kent, were reduced to a few unimportant rubbly beds in the Boulonnais. To the Portland beds the same objections existed as to the lower green-sands; both were water-bearing strata. The Kimmeridge clay was 360 ft. thick near Boulogne, and no doubt passed under the Channel, but in Kent it was covered by so great a thickness of Wealden strata as to be almost inaccessible; at the same time it contained subordinate water-bearing beds. Still, the author was of opinion that, in case of the not improbable denudation of the Portland bed, it might be questionable to carry a tunnel in by the Kimmeridge clay on the French coast, and out by the Wealden beds on the English coast. The oolitic series presented conditions still less favourable, and the lower beds had been found to be water-bearing in a deep Artesian well recently sunk near Boulogne. The experimental deep boring now in progress near Battle would throw much light on this part of the question.

The author then passed on to the consideration of the Palæozoic series, to which his attention was more particularly

directed while making investigations, as a member of the Royal Coal Commission, on the probable range of the coal-measures under the South-East of England. He showed that these rocks, which consisted of hard Silurian slates, Devonian and Carboniferous limestone, and coal measures, together 12,000 ft. to 15,000 ft. thick, passed under the chalk in the North of France, outcropped in the Boulonnais, were again lost under newer formations near to the coast, and did not reappear until the neighbourhood of Frome and Wells was reached. But, although not exposed on the surface, they had been encountered at a depth of 1,320 ft. at Calais, 985 ft. at Ostend, 1,026 ft. at Harwich, and 1,114 ft. in London. They thus seemed to form a subterranean table-land of old rocks, covered immediately by the chalk and tertiary strata. It was only at the southern flank of this old ridge that the Jurassic and Wealdon series set in, and beneath these the Palœozoic rocks rapidly descended to great depths. Near Boulogne these strata were already 1,000 ft. thick; and at Hythe the author estimated their thickness might be that or more. Supposing the strike of the coal measures and the other Palœozoic rocks to be prolonged from their exposed area in the Boulonnais across the Channel, they would pass under the Cretaceous strata somewhere in the neighbourhood of Folkstone, at a depth estimated by the author at about 300 ft., and near Dover at about 600 ft., or nearly at the depth at which they had been found under the chalk at Guines, near Calais, where they were 665 ft. deep. These Palœozoic strata were tilted at high angles, and on the original elevated area they were covered by horizontal Cretaceous strata, the basement beds of which had filled up the interstices of the older rocks as though with a liquid grouting. The overlying mass of gault and lower chalk also formed a barrier to the passage of water so effectual, that the coal measures were worked without difficulty under the very permeable tertiary and upper chalk of the North of France; and in the neighbourhood of Mons, notwithstanding a thickness of from 500 ft. to 900 ft. of strata charged with water, the lower chalk shut the water out so effectually that the coal measures were worked in perfect safety, and were found to be perfectly dry under 1,200 ft. of these strata combined. No part of the Straits exceeded 186 ft. in depth. The author, therefore, considered that it would be perfectly practicable, so far as safety from the influx of the sea water was concerned, to drive a tunnel through the Palœozoic rocks under the Channel between Blanc Nez and Dover, and he stated that galleries had actually been carried in coal, under less favourable circumstances, for two miles under the sea near Whitehaven. But while in the case of the London clay the distance seemed almost an insurmountable bar, here again the depth offered a formidable difficulty. As a collateral object to be obtained, the author pointed to the great problem of the range of the coal measures from the neighbourhood of Calais in

the direction of East Kent, which a tunnel in the Palæozoic strata would help to solve. These were, according to the author, the main conditions which bore on the construction of a submarine tunnel between England and France. He was satisfied that on geological grounds alone it was in one case perfectly practicable, and in one or two others it was possibly so; but there were other considerations besides those of a geological nature, and whether or not they admitted of so favourable a solution was questionable. In any case, the author would suggest that, the one favourable solution admitted, it might be desirable, in a question involving so many and such great interests, not to accept an adverse verdict without giving all those considerations the attention and deliberation which the importance of the subject deserved.

Granting the possibility of the work in a geological point of view, there were great and formidable engineering difficulties; but the vast progress made in engineering science during the last half century led the author to imagine that they would not prove insurmountable, if the necessity for such a work were to arise, and the cost were not a bar.

MR. S. J. MACKIE'S CHANNEL PASSAGE STEAMER.

IN the matter of the Channel passage, since the collapse of Mr. Fowler's scheme before the Committee of the House of Lords, public attention has of late been directed towards a solution of the question by means of large and commodious vessels, drawing very little water, to do the work between the existing harbours without any considerable expenditure upon those harbours for improved accommodation. So long ago as 1869 Mr. S. J. Mackie, C.E., entered on this ground, and designed a special class of vessel for the Channel service. It may be remembered that a very pretty wooden model and an iron model working by steam were in that year exhibited at the soirée of the President of the Royal Society, where they attracted much attention. The model was also shown privately to the Members of the Committee of the Society of Arts upon the subject of the improvement of the present steamers, in 1870, but was not put into competition with other models then displayed, because the inventor declined to exhibit on account of the restriction of size to vessels not exceeding 200 ft. in length, since he refused to consider any vessel under 400 ft. in length as properly suitable for the Channel passage.

The system of construction adopted by Mr. Mackie is that of a composite box-girder, or compound tubular bridge, to which the skin is fastened, forming a body or general hull like that of vessels of the ordinary type. To the merits of this mode of construction, for its strength, lightness, commodiousness, and safety, the highest appreciation has everywhere been freely given; and, indeed, there can be no question whatever as to these points;

nor can there be any other form in which better accommodation will be furnished for travellers. The experimental question really to be settled was the efficiency of the proposed mode of propulsion, there being no doubt whatever as to the steadiness of the vessel in a sea-way. To these important questions the inventor has devoted much of his attention, being most desirous that everything should be assured before his plan came before the public. In this spirit he has worked on with his model, lengthening her, deepening her, narrowing her tubes, increasing the diameter of her paddles, working her with three, two, and one pair of paddles, for effects in comparison with each other, until at last he has altered his model altogether out of the original light-draught shape, and she now represents one of the heaviest of ironclads, such as would have a draught of 65 ft., if the proportions were regulated as usual according to scale. As the model still drives with as good speed under the most unfavourable conditions that could be devised, it is only fair to concede that, *so far as any model, conscientiously worked, can determine, Mr. Mackie has good grounds for his belief that a high speed will be obtained by this mode of propulsion.*

Mr. Mackie's most recent design for the Channel Passage Vessel differs only from the original one, in having four paddles instead of six, and in being 80 ft. in beam instead of 90 ft.; this reduction of the beam being for the sake of finer lines, with a view to speed of working, which will not be less than 20 miles an hour. The details of measurement for the proposed ship are —length, 400 ft.; breadth of beam, 80 ft.; draught of water, 6 ft 6 in. The vessel is constructed in the following manner:—The bottom of the hull is nearly flat, there being just a slight rise along the median line. It is double plated, with an interval of 18 in. between the skins. Four main vertical girders extend longitudinally through the vessel from end to end, so far as the form of the bows and stern will permit. These girders are braced together transversely, by a main deck and by an upper or promenade deck, the whole being attached to the outer skin of the vessel. The central interspace, formed by the innermost longitudinal girders, constitutes the main compartment, or central hull, of the vessel; and in this are placed the boilers, engines, stores, berths for crew, and cargo. The lateral interspaces, between the inner and outer longitudinal girders, form on each side a tubular channel or waterway, open at both ends; and within these waterways are the propellers, which may be two or three pairs of paddles in each waterway, to work synchronously or separately, at the will of the engineer, who controls all the engines from a central position under the steering house. In the present case the paddle-wheels will be 24 ft. in diameter, with floats 12 ft. wide by 5 ft. deep. The water acted on, being thus confined, passes entirely through the vessel from end to end. The external spaces, between the outer longitudinal girders and the skin of the ship, form buoyant wings,

or lateral hulls, into which the baggage-vans will be lowered and covered down with water-tight hatches. The buoyancy of these outer compartments will act as an additional check upon any tendency to roll, just as a man floating on his back (as this vessel does on her central hull) could check his rolling motion by his extended arms with a bladder in each hand. Both weight and buoyancy are thus brought in to aid the great width of beam in giving the utmost steadiness to the vessel. In a longitudinal direction the flat floor of the hull, and the buoyancy of its every portion—unlike the buoyancy of an ordinary ship, which only exists in the middle body, the bows and stern being dead ends, and oscillating on the central buoyant portion—with the force of the current passing through the ship acting as a water-rope to tie the hull down to the sea, will all undoubtedly combine to give the vessel, if not absolute steadiness (which perhaps is neither attainable nor desirable in rough weather), yet certainly as much steadiness as is practicably attainable and safe in a floating structure. To prevent the vessel being wet, great flare is given to the bows, and the lines of the bottom are fined off to an unusual degree below the water.

The saloon is a very conspicuous portion of the vessel. In no ordinary ship can anything like the same extent of the best accommodation be obtained. It is one of the merits of Mr. Mackie's plan that this feature first received in it the grandest extension, which is a merit that ought not to be lost sight of in estimating the originality of different competing schemes. Instead of being a mere addition,, as hitherto, Mr. Mackie makes the saloon an integral part of the ship, adding in the largest degree to its strength and safety. The upper portions of the main longitudinal girders are brought up above the maindeck, and boxed in by the upper or promenade deck, thus forming a magnificent saloon 300 ft. long, 60 ft. wide, and 12 ft. in height. The longitudinal girders are in this way brought to 26 ft. depth of web, and give immense strength. These girders, as well as the bulkheads across the hulls, give also the capacity of taking all the strains in the place of the plates, and relieve the torsions of the outer skin, which are so detrimental to the endurance of our present ships.

At first sight, the friction of the water through the waterways might seem an impediment to the propulsion. But on closer examination many of the difficulties vanish, particularly when the balance of results is struck. Thus the action of the tubes in releasing the head resistance is beneficial, in causing shorter throws of the water from the bows, and in giving direct force to the columns of water expelled, instead of a large amount of force being lost by the lateral dispersion of the water from outside paddle-wheels. Some considerable discussion has arisen as to the necessity of running the following paddles at higher speed than the intake paddles; but Mr. Mackie asserts that he gets the best results by working all the paddles together,

stroke for stroke, the paddles of all the wheels dipping into the stream together. In rough weather there will be this advantage, that the current passing through the tubes will be pretty uniform, and therefore the irregularity of wave-action, so formidable to ordinary steamers, will be avoided. It would be a mistake to suppose that in the Mackie vessel the waves have free access to the body of the vessel. The waves are prevented from rushing into the tubes by the limited space that is left above their mouths—not more than from a few inches to a foot above the load draught-line. The upper part of the waterway also is grated, to prevent the swallowing up of boats, if they were unhappily run in to at night or in a fog; as also to prevent the entrance of any foreign bodies that may be floating in the sea.

The time of working the engines, moreover, in the Channel passage being but little, if anything, over one hour for the voyage across, the consideration of cost of working may be dismissed, so far as this passage is concerned, in view of the more imperative essentials of the steadiness and comfort of the vessel. The fact, however, is that, on working out the resistances and speed upon the accepted rules, the results, both as to resistance and speed, are highly favourable.

Various designs for war-ships, river-boats, and canal-boats, have also been prepared by Mr. Mackie, with a view to ascertaining the powers of speed and the resistance of the new form of hull under varying conditions of weight, draught, and size. The results in every case are highly satisfactory. It is probable, from the cautious and inquiring character of the inventor, that, had it not been for the antagonism of rival schemes, he might have waited longer and spent yet more time on his researches. But enough, he considers, has been done to justify the building of a trial vessel of 140 ft. length, 22 ft. beam, and 3 ft. draught, to settle the question of propulsion before going to the public for a company to carry out the invention with a view to commercial profits.—*Abridged from the Illustrated London News.*

COAL IN SARAWAK.

A CORRESPONDENT writes to the *Times*: "In the Parliamentary Report on coal, 1873, it is stated that the Coal exported to foreign countries has increased from 9,283,294 tons in 1865 to 13,211,961 tons in 1872, and it will be instructive to notice what sources of supply may assist in lessening this outflow, since the more coal that is available for steam and industrial purposes at home, the better our manufacturers will be able to maintain that command of foreign markets which has hitherto been regarded as the heritage of this country. While the New South Wales coal is meeting the demand in the southern hemisphere, and a considerable portion of the coal used in North China and Japan is drawn from the latter country, large deposits of bituminous, anthracite, and cannel coal, have been

brought to light in Sarawak during the past 12 months, where exploring parties have been organised by the Rajah Brooke. There is now little doubt that, sooner or later, Singapore, Hong Kong, the Malay Archipelago, and perhaps Galle, will be supplied with Sarawak coal of a quality to meet every requirement for steam, gas, or other purposes. The Sarawak Government is now working a vein of coal for the use of its own steamers a short distance up the Sadong River, not far from the sea; this is inferior in quality and very easy of access. Near Mukah, on the sea coast of the Mukan Residency, a vein of cannel coal of great thickness has been traced for a considerable distance, and been found cropping out in fourteen different places over an area of 20 miles. A vein of similar cannel has been discovered up the Rajong river, which is navigable nearly 200 miles for small steamers; and many other outcrops of coal have been brought to light, of which that found in large quantities at Silantek has proved the most important. This latter, a steam coal stated to be equal to West Hartley, has been raised, and tried at Singapore with remarkable results. This trial was made on board the steamship Agnes, fitted with ordinary compound surface-condensing engines, the diameters being 47½ in. in the high pressure and 25½ in. in the low pressure cylinder, with a stroke of 2 ft. 9 in. During the 6½ hours the vessel was at full speed at sea the steam was from 50 lb. to 55 lb. pressure in the boiler, and indicator cards taken every half-hour gave a mean horse-power of 330·71; 4,196 lb. of coal was weighed and consumed, giving an average of 762 lb. per hour, an equivalent of 2 lb. 6 oz. per indicated horse-power per hour; the furnace refuse was 7½ per cent. of coal consumed; the combustion was perfect, with a very little light grey smoke. Making the usual allowances, it may be taken that less than 2 lb. per horse-power per hour would suffice on an ordinary voyage. The coal used was surface coal, and could hardly be expected to yield its full power. The crop of the main seam of this Silantek coal has been opened up for nearly two miles; it runs from 4 to 5 ft. thick, and is available for surface working at a gentle angle. Quite lately coal of the same kind as the above has been found at the mouth of the Sibuyan River, near the sea, where it crops out of six hills of a considerable size and has many faculties for working. The existence of these deposits, and their utilisation through the medium of Chinese labour, can hardly fail to be a matter of importance to our Eastern carrying trade, and all interested may hope that the bad name attaching to Eastern coal will become a thing of the past. There are few points in the far East where it is more important to command an unfailing supply of steam fuel than at Singapore and the Straits of Sunda; our China trade cannot fail to welcome its production, and the newly projected railways in Java will doubtless create a local demand for good coal which at present it is difficult to meet."

COAL CUTTING.

Mr. Firth has read to the British Association an interesting paper on the application of machinery to Coal Cutting, giving a full description of the machine. It is driven by compressed air, and works by "picking," in a similar way to, though much more effectually than, the "hand-pick" at present in use. A youth of ordinary capacity can acquire, in a very short time, sufficient knowledge to undertake the duty of guiding one of these machines, which does the work of twelve men. It appears that with well-constructed machinery 40 to 50 per cent. of the steam power exerted can be given off in compressed air at a density of three atmospheres in the receiver, and that this pressure is sufficient for the effectual and economical working of the machnes. It is calculated that the equivalent of a man's power, exerted by the machine for a whole day, is obtained at a cost of fuel of 3¼*d.* In addition to other benefits from the use of compressed air, the cooling effect from its discharge at each stroke of the piston, reducing the temperature of the mine, is found to be conducive to the comfort of those engaged in working, and, besides this, the ventilation is improved. Further, too, in the event of an explosion, the poisonous effect of after-damp or foul air generated can be mitigated; and in case of fire the pipes can be used for conveying water to the spot, and such use has actually been made of them. It was estimated that an allowance of 2*d.* a ton would in three years liquidate the entire outlay for the machinery.

The Nant-y-glo coal-cutting machine was described in a paper by Dr. Clapp. This machine is also driven by compressed air, and acts by means of a series of rotating drills which perforate the coal, at the same time breaking down the divisions between the holes bored.

THE ECONOMIC CONSUMPTION OF SMOKE.

The operation, at Glasgow, of Messrs. T. & T. Vicars's patent self-stoking smokeless furnace, which is perhaps a little better known in England than in Scotland, is thus spoken of in the *Glasgow Herald*:—It meets the case more thoroughly than any invention of a similar kind that has hitherto come under notice, and is as simple in construction as it is efficient in operation. The coal is placed in a hopper, over the front part of the furnace, into which it falls in small quantities through a couple of apertures. It is not necessary to open the front door of the furnace, except to see how the fire is getting on, for by a simple mechanical readjustment the man in charge of the furnace may regulate the quantity almost to an ounce. As it is added to from above, the coal sinks down, and slides slowly inward until it reaches the bars forming the bottom of the furnace. These bars are acted upon by plungers, which carry them forward together,

with their layer of coal on the top, and then, an eccentric being applied, every third bar in the series is brought back to receive a fresh supply. In this systematic and continuous way the furnace is fed with coal, which passes right through in slow and easy stages, the same quantity of fuel being at all times in exactly the same state. Combustion is therefore perfect, the *smoke is burnt up, and the waste fuel is discharged, in the form of clinker or slag, into the ash-pit. The works of which we* have been speaking are those of Messrs. Crum, at Thornliebank, where upwards of thirty of these furnaces are in operation, and others are being erected with all diligence.

ECONOMIC CONSUMPTION OF COAL.

THE Manchester Society for the Promotion of Scientific Industry have been engaged for some time in preparing an exhibition of appliances for the saving of fuel, to be held in Peel Park, Manchester. The exhibition is divided under eight classes, viz.:—

1. Appliances which may be adapted to existing furnaces, &c., whereby an improved combustion of fuel is secured, and a direct diminution of the quantity required is effected. 2. Appliances which may be adapted to existing steam-boilers, &c., whereby the waste heat of flue gases, or of exhaust steam, is utilised. 3. Appliances which may be adapted to existing steam-boilers, pipes, and engines, whereby loss of heat from radiation and conduction is prevented. 4. New or improved furnaces (using solid, liquid, or gaseous fuel), boilers and engines of all descriptions, specially adapted for the saving of fuel. 5. Natural and artificial fuels of all kinds. 6. Coal-cutting and peat-manufacturing machines. 7. Domestic and other fire stoves, ranges, and apparatus of all kinds (using coal, gas, or other fuel) for cooking, or for warming rooms and buildings. 8. Miscellaneous. As far as can be judged, at the present stage of the arrangements, each of the above classes will be well represented.

About 500 appliances of different classes were displayed in a wooden building, 260ft. by 50ft., with three annexes for large exhibitors. The catalogue included some of the smallest and simplest contrivances, as well as ponderous boilers and engines, with all the latest improvements that have been devised under the stimulus of increasing cost of fuel. It may be stated generally that the exhibition is not confined to novelties. It includes many comparatively old and well-known inventions. The aim of the promoters has been not so much to offer premiums or rewards to inventors, as to draw public attention to what has already been done in the required direction, and then to point out the path in which inventive skill may be most usefully exercised.

In regard to the saving of fuel in manufactures, it is desired especially to bring under notice the advantages of high-

pressure boilers, for it is felt that steam as well as fuel has been wasted. The exhibition included a globe high-pressure boiler, sent by Messrs. Sanderson and Proctor, of Huddersfield; a tubular boiler, by Mr. G. Sinclair, of Leith, which is capable of working up to 300lb. to the square inch; and a 60-horse Rood's boiler, by the Patent Boiler Company, of Birmingham. *Among other exhibits in this department are* a 4-horse agricultural engine with spiral bar apparatus for securing greater economy in coal, by Messrs. Young Brothers, of Liverpool; and a patent grate or series of grates, for furnaces, by Messrs. Bolgano, Tedesco, and Co., of Prague. There were also a fuel economiser for railway locomotives, mechanical stokers, various machinery for the cutting of coal and making of peat, and a large number of other inventions with the same end in view. The wide range over which exhibitors extended was remarkable. On the one hand we find an excellent artificial fuel easily manufactured and remanufactured with the aid of silicate of soda and coal tar from the ashes and refuse of an ordinary fire, the discovery and patent of a lady; and on the other hand the drawing of a set of three furnaces, fixed one above the other, for the purpose of consuming the smoke and of securing a more efficient use of fuel, contributed by an old Captain of the Royal Navy. After serving his country professionally for fifty years, he is desirous of rendering in his old age a further service if possible.

The domestic department was well represented, and there was every imaginable contrivance for effecting a saving in the consumption of household coal. Dr. Crestadoro, the chief librarian of the Manchester Free Library, exhibited an ingenious self-feeding grate. There were also stoves specially constructed for the burning of peat, a novel kind of shovel for feeding fires at the bottom instead of from the top, and a large number of improved house grates. The general tendency of the inventions in this direction is to lessen the consumption by narrowing the area of the fire; in some cases to shut it out of sight altogether. The model of an invention which possesses importance from a sanitary point of view was exhibited by Mr. Stott, of Halifax. This is a ventilating drain, by which the noxious gases are not only destroyed but utilised by being consumed in the fires, with which the drain is placed in direct communication by means of a pipe, which can be turned off or on at will. A large number of drawings and models were shown. As far as possible the various apparatus were in action. Suitable brickwork was provided for the fire grates, and steam power for such of the exhibitors as required it.

THE LIBOTTE SAFETY CATCH.

The Safety Catch of M. Libotte, which has found a wide application at the collieries of Belgium and the North of France,

has proved its value at the colliery of "Conception," near Mont-sur-Marchienne, where the pit rope broke when drawing up the cage loaded with four tubs of coal. The catch or parachute acted instantly, and forced its claws in the guiding beams 1·5 centimetres deep, and after only sliding downwards ½ metre brought the cage to a standstill, and kept suspended a weight of 5,410 kilog., or 5½ tons, viz. the cage 1,700 kilogs., 4 loaded tubs 1,960 kilogs. and 250 metres of wire rope 1,750 kilogs. This apparatus merits its reputation, and acts well when the rope breaks winding up, but is not reliable when going down.

SUPPLY OF PETROLEUM.

THE *Titusville (Pennsylvania) Herald reports that the old oil wells are falling off rapidly*, but new wells coming in appear to keep up the production. No new wells are started from the top of the ground, but no one can see the end of the fourth sand development. The *Herald* says:—"With present low prices the question of employing petroleum as fuel is again agitated. The latest intelligence upon the subject comes from Canada, where a man named Relighine has been trying an experiment on a locomotive belonging to the Canada Southern Railway, with an average consumption of 4 gallons per mile. The engine steamed quite freely, and made good time with a train of 30 cars. This would be about a barrel for every ten miles. The most simple contrivance for burning petroleum is either by means of a jet of steam or compressed air passed at right angles over the orifice of a pipe in such a manner that the oil will be sucked up and thrown into the furnace in the form of a fine spray, where, if properly adjusted, it will undergo perfect combustion. The cost of the apparatus is trifling. The whole point, it seems to us, turns upon cheapness, and as the market might go up rapidly with any marked increase of demand, there seems to be an indisposition to try the experiment. There can be little doubt that oil will be found in many parts of the country where at present it is not thought of, in which case a new and unlimited market for its utilisation as fuel would naturally follow." A Californian paper states that oil has been found on the bank of the Paiaro river.

THE PETROLEUM TRADE.

IT is proposed to form a company to lay a pipe from Petrolia to London, in the province of Ontario, Canada, for the conveyance of oil, in consequence of the difficulty experienced in obtaining prompt deliveries by railway. As the two places are on a level, pumps will have to be erected at intervals of about 10 miles to force the oil into the next pumping-place. The distance to be overcome is about 60 miles, and the cost is estimated at 100,000 dollars.

ROCKETS FOR ASHANTEE.

WAR rockets may be said to be portable artillery. In many positions, owing to difficulties of transport, the use of artillery in the ordinary manner is either altogether impossible or, at best, very limited. The weight of a piece of ordnance and the violent recoil produced by the explosion of the charge of gunpowder will always render the employment of a gun—even of the lightest description—more or less laborious. The adoption, therefore, of a military engine which without the drawbacks inherent to the gun would possess projectile power was a great desideratum. This want led Sir William Congreve to construct the war rocket, which, as he says, is *ammunition without ordnance—the soul of artillery without the body. A war-rocket consists of a cylindrical metal case containing an inflammable composition. To one end of this case a hollow thimble-shaped* iron head is attached, which may be filled either with gunpowder or carcass composition; the other end is closed, with the exception of one or more vents or holes to admit the escape of the gas from the ignited composition. The rocket invented by Sir William Congreve, as well as the improved pattern subsequently introduced by General Boxer, was fitted with a stick or long wooden rod, attached to its base; this served to keep it steady in flight. But rockets of this description were superseded in 1867 by the Hale rocket, in which the stick is dispensed with and rendered unnecessary by a contrivance for giving rotatory motion to the case during its flight. The iron case of the Hale rocket is manufactured from a kind of semi-steel known as Atlas metal. The sheet of metal is first formed into a hollow cylinder with lapped edges, then rivetted and brazed at the longitudinal joint; the cast iron hollow head, the hollow being filled up with wood, is then rivetted on to one extremity of the cylinder. The inside of the case is corrugated in three places to give it a better hold on the composition, and the latter is separated from the head by a disc of millboard. The composition consists of the elements of gunpowder, but the proportions are such that when ignited it burns fiercely instead of exploding.

In the nine-pounder rocket now in use against the Ashantees the composition consists of 69 parts saltpetre, 12 parts sulphur, and 19 parts charcoal, whereas that of gunpowder is—saltpetre 75, sulphur 10, charcoal 15. The composition is introduced into the case in successive pellets, and pressed by hydraulic power into a solid column, which is afterwards bored out in a cone for about two-thirds its length; in the nine-pounder rocket this hollow cone in the centre of the composition is about 7½in. in length, leaving a solid column of composition about 1¼in. in thickness between the inner extremity of the cone and the millboard disc. The rocket owes its projectile power mainly to the presence of this cone or cavity in the inside. If the composition were solid throughout, only a small surface would ignite, and

the rocket would in that case simply burn like a squib until a considerable portion of it had been consumed. But the interior cavity causes a large surface of composition to be ignited the moment the rocket is fired; the gas is thus generated within the case more rapidly than it can escape through the holes or vents in the base, and the result is a great pressure acting in all directions inside the rocket. The pressure on the sides mutually balance one another; but as the pressure on the tail is relieved by the escape of the gas, that on the head is greater than that on the base; consequently, the rocket moves forward in the direction of the greatest pressure. In fact, the force which produces motion in the rocket is somewhat similiar to that which produces recoil in a gun; but whereas recoil is a retarded motion due to a sudden impulse which ceases when the projectile has left the muzzle, the flight of a rocket is an accelerated motion due to a constant force which acts until the composition has burnt out.

The rocket was first introduced into the British service in 1806, strictly as an incendiary projectile. At this period the only means of bombarding and burning towns and shipping was by mortar fire, for although shells were fired from howitzers with small charges about 1700, it was not until 1822 that General Paixhans pointed out the proper use of shell-guns for horizontal fire. In the early part of this century, therefore, bombardments were effected by discharging either common shells or carcasses—projectiles filled with inflammable composition—from comparatively ponderous pieces of ordnance, such as 13-inch, 10-inch, and 8-inch mortars. The 10-inch sea service mortar weighed over 50cwt., and fired a spherical carcass-shell of 105lb., filled with about seven rounds of composition. The latter was ignited by the discharge of the piece and burnt very fiercely for about nine minutes, the flames issuing from three vents. This projectile, therefore, on falling among combustible material produced a conflagration, but such was the force of its descent from the height to which it had been thrown by the mortar, that, on falling upon a building, it frequently went through the roof and all the floors of the house until it ultimately buried itself in the cellar, where there was nothing combustible. The 32-pounder rocket, on the other hand, also contained about seven pounds of carcass composition in its head, but was about one third of the weight of the 10-inch shell. It could be easily carried by one man, and discharged by means of a tube of a simple and light construction. Moreover, it would range even further than the 10-inch shell, and, owing to its comparative lightness and shape, would lodge somewhere inside the body of the house it struck; it was therefore more likely to cause a conflagration. Rockets appear to have been first used by us in the bombardment of Boulogne in 1806, when 200 rockets were discharged and the town set on fire in many places without the slightest opposition or loss being incurred by the attacking party.

They were subsequently used with great effect during the siege of Flushing.

But although Sir William Congreve's first idea was an incendiary projectile which was to be thrown in large numbers from boats into a seaport town or a harbour crowded with shipping, the system gradually expanded until it comprehended military as well as naval operations. The 32-pounder rocket was after a time abolished, and 24-pounders, 12-pounders, and 6-pounders introduced, and in 1813 rocket troops of Royal Artillery were formed. The service rendered by the rocket detachments attached to the Allied Army at Leipsic is a matter of history. In telling the story of the battle Sir Edward Cust says that the destructive effects of the flights of rockets was so fearful, that a whole brigade surrendered after being a few minutes under their fire. But this was by no means the first occasion on which rockets were used against troops. They had long been known to and used by Eastern Powers, and Tippoo Saib taught us the value of the rocket as a projectile during the siege of Seringapatam in 1799, when the British troops are said to have suffered more from the enemy's rockets than from shells or any other weapon.

Thus by degrees the rockets was generally adopted as an engine of war both for naval and military purposes, and gradually its original object came to be lost sight of. Carcass-rockets went out of fashion, and shell-rockets were introduced with time fuses and all the paraphernalia for boring them. The cast-iron head of the rocket was fitted with a fuse, next the composition and a small hole in the apex for the insertion of the bursting charge, through which the boring machine—somewhat similar to a bit and brace—was introduced when it was required to bore into the fuse composition. When the rocket was to act as a shell, the screw plug in the apex was removed and the fuse composition bored into for a depth corresponding to the distance at which the shell was required to burst; the bursting charge was then poured in and the screw-plug replaced. Now this operation was a work of time, and the service of the rocket was proportionally delayed. Moreover, the shell-head, even of the largest sized rocket, the 24-pounder, only contained about 9oz. of gunpowder, while that of the 12-pounder did not hold half that quantity. These considerations led the Ordnance Select Committee in 1866 to recommend that the use of war rockets as shells be discontinued, and when Hale's rockets were introduced in the following year, the hollow in the cast-iron head was simply plugged up with a piece of oak. In fact, as at present manufactured, the rocket as a man-killing projectile acts mainly as a shot, while its incendiary powers are confined to the flames which issue from its tail—that is, to the burning of the rocket composition, which only lasts a few seconds. We readily join with Sir Samuel Baker in deprecating this arrangement. This form of artillery appears to us to have neither soul nor body.

We by no means wish to reintroduce fuses and thus complicate the service of rockets, but we think the piece of wood in the head might be advantageously replaced by gunpowder or, perhaps, by a more powerful explosive—picric powder, for instance. The wood is a perfectly inert substance and is of no value whatever, whereas the gunpowder would, at any rate, blow the cast iron head to pieces when the composition had burnt out, and might thus cause some destruction. But the modification we should like best would be a return to our first love. We have introduced rifled guns without adopting a special incendiary protectile (common shells excepted), and it seems to us that rockets might be made to undertake this *rôle*. Thus the primary object of Sir William Congreve would be kept in view. Possibly, even the principle of the rocket may be successfully applied to the transmission of torpedoes either under water or through the air, but in any case the destructive powers of the engine should not solely depend on its motive power. Sir Samuel Baker appears to have just cause of complaint when he points to the non-incendiary powers of the Hale rockets used by him; and although the rockets supplied to the Gold Coast expeditionary force appear to have acted well in a man-killing sense, still Sir Garnet Wolseley would undoubtedly find less difficulty in setting fire to Coomassie if these engines had a carcass head instead of a wooden one.—*Times.*

NEW SAFETY-LAMPS FOR MINES.

At a meeting of the North Staffordshire Institute of Mining and Mechanical Engineers, Mr. Teale, of Manchester, laid before the members a new safety-lamp. He explained that while the lamps at present in use were imperfect as to illuminating power, and were easily tampered with, the lamp he produced gave double the light, could not get out of order, was more economical than the ordinary lamps in use, and could not be tampered with by workmen. He lighted a lamp and showed that it could not be unlocked without being extinguished; at the same time, the screw used for unfastening it regulated the light. The lamp was less likely to get out of order than other lamps, because a sponge was saturated with oil and the wick was attached to it, all superfluous oil being poured out before entrusting the miner with the lamp. Mr. Oswald, of Harecastle, then introduced a lock for safety-lamps, patented by Messrs. Craig and Bidder. The ordinary lamps, he explained, are used, but they are made to be self-locking, and can only be unfastened by a powerful magnet, which is kept in a strong box under lock and key, under the charge of one man in each pit. By this means much saving of time is effected in lighting lamps, and lamps can only be opened in the place of safety where the magnet is kept. Mr. Oswald said the lock he showed had been tested in the Harecastle Colliery three years. Mr. Teale said

his had also been thoroughly tested. There was a short discussion, to be renewed at the next meeting of the Institute, as to the merits of both attempts to secure the safety of miners. No resolution was passed, but the magnetic lock seemed to be greatly favoured.—*Times.*

WENDHAM'S HEATED AIR ENGINE.

At a meeting of the Institution of Mechanical Engineers a paper has been read "On Wenham's Heated Air Engine," by Mr. Conrad W. Cooke, of London. Of the many attempts that have previously been made to employ the expansion of heated air for producing motive power, the most important in practical results were those of Stirling and Ericsson, in each of which the air was heated in a closed vessel over a fire. But the low-conducting power of air rendered this a very imperfect mode of heating it, and the extensive repairs necessitated by the burning out of the bottom of the heating vessel caused Stirling's engine to be abandoned after having driven the work of a foundry for three years. In Cayley's heated air engine, which was a previous invention, the fire was enclosed in an air-tight chamber, and the air for working the engine was pumped in partly below the fire for supporting combustion, and partly above the fire, mixing with the products of combustion, the whole of which was passed through the engine; this plan has an important advantage in the direct mode by which the air is heated. In Wenham's engine the same principle is employed, with the distinctive feature that no separate air-pump is employed for compressing the air, this being effected at the top of the working cylinder by increasing the clearance space and making use of the cushioning for the purpose. The engine has a single-acting vertical cylinder, the upstroke being made by the pressure of the heated air below the piston, and the engine is carried through the downstroke by the flywheel. The external cold air, admitted by an inlet valve into the top of the cylinder during the downstroke, is compressed during the first half of the upstroke, and is then delivered during the remaining half stroke through a weighted valve into the furnace chamber; the delivery passage is divided into two branches, one conveying a small portion of the air beneath the firegrate for maintaining the combustion, while the greater part of the air is conveyed by the other passage into the upper portion of the furnace chamber above the fire. A swing valve at the junction of the two branch air-passages determines the relative proportion of air delivered through each, and this valve being controlled by the governor of the engine, regulates the supply of air to the fire, and consequently the combustion of fuel, exactly in proportion to the work done by the engine. From the furnace chamber the heated air, mixed with the products of combustion, is admitted by a lifting valve into the bottom of the working cylinder during

the upstroke, and in the downstroke it is discharged into the atmosphere through an exhaust valve, these two valves being opened alternately by a cam on the flywheel shaft, and closed by a spring. The furnace chamber is of cylindrical shape, lined with a thick wall of firebrick containing a number of highly heated vertical flues, through which the products of combustion pass, causing a perfect combustion of smoke; the central part of the furnace is filled from the top with a charge of fuel sufficient to last throughout a day's working, and the furnace is then closed air-tight both at top and bottom. The working surface of the cylinder is protected from exposure to the heated air and products of combustion by a protecting drum below the piston, adopted from previous air engines, which nearly fills the diameter of the cylinder, and is of greater length than the stroke of the piston; and any dust entering the cylinder is blown out at the exhaust from the bottom. The piston is lubricated with a dry plumbago powder, and in practice the cylinder is found to maintain a good working face, and to be as durable as those of steam engines. This air engine has proved very successful for cases where a small amount of power is required, and has the advantage of working for long periods without requiring attention either for firing or for the engine, and with freedom from the risk of explosion or fire attending the use of a steam engine. —*Engineering*.

MODERN STEEL.

THE President of the Section of Mechanical Science of the British Association, Mr. W. H. Barlow, took for the staple of his opening address Modern Steel, a material which, though of comparatively recent origin, has already become an important industry, and the influence of which in the future he considers destined to vie in importance with that resulting from the introduction of iron. Seventeen years ago the movement was commenced by Mr. Bessemer, who read a paper on the subject at the Cheltenham meeting of the Association, and subsequently further important steps were taken in the production and treatment of steel by Dr. Siemens, Sir Joseph Whitworth, and others. The question was raised, "What is steel?" and, simple as the question seems, there was no ready reply. We now have "Bessemer steel," "puddled steel," and "homogeneous iron"—terms which themselves indicate the uncertainty attaching to the quality and properties of the new material. In 1850, according to the Jury Reports of the Exhibition of 1851, the total annual production of steel in Great Britain was 50,000 tons. At the present time the Bessemer process alone supplies upwards of 500,000 tons, the Siemens works at Landore 200,000 tons, besides further quantities made by his process at other works. This new material is now largely in use for rails and wheel tires, the duration of steel rails being variously estimated at

from three to six times that of iron rails. Steel is used for ships' plates and for the lining of the heaviest guns, whilst Sir Joseph Whitworth and Krupp make guns entirely of steel, though for these purposes the metal is of different quality and differently, treated in order that it may withstand the enormous concussions to which it is subjected. Steel, again, is used for railway axles, crank axles for engines, in boilers, in piston-rods, in carriage springs, and for many other purposes. Notwithstanding these various employments of steel, there has been, and still is, a difficulty in applying it to engineering structures in this country. It was to this point the President drew special attention.

A Committee of the Institution of Civil Engineers conducted a series of experiments in 1868, and much valuable information was thus obtained. As for the "mild steels" of the Bessemer and Siemens-Martin processes, it may be taken as a result that this material is capable of bearing a strain of 8 tons to the inch, instead of 5 tons to the inch, estimated for like purposes in iron. Taking the ordinary form of open wrought-iron detached girders, the limiting span in iron, with 5 tons to the inch, is about 600 ft.; it follows that a similar steel girder capable of bearing 8 tons to the inch would have a theoretical limiting span of 960 ft., practically 900 ft. Take the case of the Menai Bridge, a work erected when the application of wrought iron to engineering works was in its infancy, and when wrought iron was the only available material for such a purpose; if this work had now to be constructed, and an open girder of steel were adopted in the place of plate iron, the weight of metal would be little more than one-third of that used, and the cost and time of erection would be materially reduced. The question then arises, why is it that, with all these obvious advantages, steel is not more largely adopted? The reason is twofold: 1st, There is a want of confidence as to the trustworthiness of steel, in regard to its toughness, and its power to resist fracture from sudden strain; and 2nd, Steel is produced of various qualities, and we do not possess the means without elaborate testing of knowing whether the material presented to us is of the required quality for structural purposes; and involved in this is the fact that in the regulations of the Board of Trade, although rules are laid down for the employment of cast and wrought iron, steel has not up to the present time been recognized. No doubt some of the steel produced is what is termed "cold short," that is, brittle. Irregularity arises mainly from the difference of the chemical constituents and the various processes adopted by different makers. Be this, however, as it may, the Bessemer process, carefully conducted with ores and metal of suitable chemical constituents, produces a quality certain and regular in its results. The same may be said of the Siemens' process, though there is not the same necessity for purity in the ore or metal, and tests can be applied during the process of manufacture which ensure

regularity in the material turned out. Sir Joseph Whitworth employs intense pressure on the metal while in a fluid state, thus squeezing out the air-cells, and producing large and perfect castings of great ductility.

Chemistry aids us but little, if at all, as a test for the quality of steel; and it is on mechanical tests we must rely, and these engineers may apply for themselves; *but such tests are not of a character which affords* sufficient criterion that the metal possesses that degree of toughness which is necessary to resist the action of sudden strains. But assuming the tests and mode of testing satisfactory, and the metal of right quality, the Government Inspector must be satisfied; but how is he to be satisfied before he gives his certificate that the structure is safe for public traffic? If distinct evidence could be adduced that the metal for a bridge was of a quality which would bear 8 tons to the inch with as much safety as common iron can bear 5 tons, no doubt the Board of Trade would make suitable provision for the use of such material. But the difficulty lies in the want of something by which the quality may be relied on by others than those by whom it is made. The first step is therefore to put testing on a systematic and satisfactory basis, and next to establish some means by which the metal when tested can have its quality indicated so as to be practically relied on.

The President entered into valuable technical details in regard to these matters, adding, "All these materials are called steel, and have the same external appearance; but possessing, as they do, such a range of strength and such a variation in ductility, it becomes absolutely essential that there should be some classification or means of knowing the respective qualities among them. The want of such classification casts an air of uncertainty over the whole question of steel, and impedes its application. To this want of knowledge is to be ascribed the circumstance that many professional men regard the material as altogether unreliable; while large consumers of steel, in consequence of the uncertainty of the quality they buy in the market, seek to establish works on their own premises and make their own steel. This step has already been taken by one of the large railway companies, and is contemplated by one of the principal constructive departments of the Government. Not only is a large and useful field for the employment of steel practically closed, but the progress of improvement in engineering structures is impeded both in this country and in other parts of the world where English engineers are engaged; for, in consequence of the impediments to its employment in England, very few English engineers turn their attention to the use of steel. They are accustomed to make their designs for iron, and when engaged in works abroad where the Board of Trade rules do not apply, they continue for the most part to send out the old-fashioned ponderous girders of common iron, in cases where the freight and difficulties of carriage make it extremely desirable

what structures of less weight and more easy of transport should be employed.

"In conclusion," the President said, "we possess in steel a *material which has been proved, by the numerous uses to which it is applied, to be of great capability and value. We know that it is used for structural purposes in other countries, as, for example, in the Illinois and St. Louis Bridge, in America—a* bridge of three arches, each 500 feet span; yet in this country, where 'Modern Steel' has originated and has been brought to its present state of perfection, we are obstructed by some deficiency in our own arrangements, and by the absence of suitable regulations from the Board of Trade, from making use of it in engineering works."

THE NEW STEEL AND IRON WORKS AT SHEFFIELD.

Of the new works of Messrs. Brown, Bayley, and Dixon, Attercliffe, Sheffield, some additional facts are given in a somewhat discursive article published by the *Sheffield Telegraph*. From this source we learn that the works cover some 15 acres, to which we may add that the firm have thought fit to purchase as much more on the opposite side of the railway and canal which skirt their works. The rail mill is about 400 ft. in length, some 50 ft. in height, and is of proportionate breadth. This is filled with suitable powerful mills and machinery, the engines having been produced by the Butterley Company, Butterley, and Walker, Eaton, and Co., Sheffield. Something like 4,000 tons of steel rails per month can be rolled in this mill, the firm having already some good orders on hand. The two saws for cutting off the rail ends, planing, double-punching machines, the cogging mill, and the 80 horse-power engine for working the last-named, are by various makers, and there is also a roll-turning machine, made by Messrs. George Thompson and Co. In the rail mill there are altogether seven boilers and fourteen furnaces. There are, as well, rolling mills for steel boiler plates, and a special train of rolls for the firm's particular make of steel. The article then proceeds to state that the Bessemer-house is capable of producing 2,000 tons per week, to which end there are 4 converters (6 tons each), 12 cupolas, 6 hydraulic cranes, and a pair of hydraulic pumps to work the accumulator and the cranes. The blowing engines used in this process have steam cylinders 40 in. diameter and 5 ft. stroke, and blowing cylinders 60 in. in diameter. The Bessemer-house is next the rail mill, whence the finished articles are delivered direct on to the rails, a locomotive being owned and employed by the firm for shunting purposes, so that there is every convenience in this respect. There is also a tyre mill equal to the production of about 1,000 finished tyres per week, the mill itself being of very large dimensions—170 ft. by 130 ft. In it there is a mill and engine by Collier and Co., Manchester, and one by Galloway

and Co. The four steam hammers are the work of Thwaites and Carbutt, Bradford, and Davy Brothers and Co., Sheffield, two of 8 tons by the former, and two of 5 tons by the latter. The spring-shop is described as an exceedingly fine one, as indeed it is. Its one roof covers an area 386 ft. by 136 ft., with an elevation of 34 ft. Under this are carried on the rolling, forging, fitting, and other operations proper to such a place. The steel rolling mill therein is by Messrs. Davy Brothers and Co., Sheffield. There are also 15 furnaces, 16 water tanks (with a total capacity of 80,000 gallons), and 96 fitting-places. All kinds of railway-springs are made, and notably the conical ones invented by Sir John Brown. Besides these there are departments specially devoted to the smiths (this one has 60 fires blown by three Lloyd fans, which are in turn driven by three engines), the founders, buffer-makers, axle makers, carpenters and engineers. To these must be added the space devoted to the draughtsmen's offices, and the general offices of the concern. In the buffer shop are 5 steam hammers, chiefly used in forging buffer plungers. The axle shop contains three double-action hammers, varying from 50 cwt. to 4 tons. The engineers' shop is fitted up in the usual way, but on a very large and comprehensive scale.

THE FIRST GUN OF THE GREAT CIVIL WAR.

A CURIOUS instance of the correction of a current historical error by careful inquiry comes to us from the United States. It had been generally thought that the First Gun of the great Civil War was that fired on Fort Sumter; while other accounts have given the doubtful honour to a battery at Pensacola Harbour, in Florida, where Admiral Porter, then but a lieutenant, distinguished himself by reinforcing the United States' garrison with extraordinary vigour and promptitude before the actual outbreak of the war. But the War Department at Washington has ascertained on clear evidence that the original overt act of hostility was committed at the then very little known city of Vicksburg, on the Mississippi, where an attempt was made, some days before the Charlestown and Pensacola affairs, to stop a small steamer passing down the stream with stores on board belonging to the Federal Government. As the armament of the place at that time consisted of but one four-pounder, the property of the city, and intended for salutes, it is not surprising that the steamer went by unhurt; and the circumstances had been almost forgotten in the greater events of which Vicksburg was the scene, until late inquiries revived the memory of them. The gun was brought away when the works of Pemberton were dismantled after his surrender to Grant in 1863, and was lately found in the Ordnance Stores at Washington, whence the President has directed it to be sent to West Point, and presented to

the Academy as a public memorial of the triumph of the cause against which it was used for the first act of defiance.—*Pall Mall Gazette.*

IMPROVED IRON.

Among the various expedients for improving the quality of Iron contaminated with phosphorus, one that has been often proposed is the use of the fluor spar in the puddling process. But the beneficial results said to have been derived from this addition have not, on more extended experience, been hitherto sustained. At the Bowling Ironworks, however, and also at some other works, a process called the Henderson process, for the improvement of the quality of inferior iron by the addition of fluorine in the puddling, is said to have given very satisfactory results. By its aid cinder pig, it is stated, may be puddled into wrought iron of high quality.

A WROUGHT-IRON OBSERVATORY.

A paper has been read to the Institution of Mechanical Engineers, describing "A Wrought-iron Construction of Observatory for Maintaining Equality of Internal and External Temperature," by Mr. Charles Clement Walker, of Donnington. The object of this construction of observatory is to obtain uniformity between the temperatures of the internal and external air, so as to prevent the accuracy of observation with the telescope from being impaired by currents of air of different densities, such as occur when a difference of temperature exists in the surrounding air. For this purpose the walls of the building as well as the roof are constructed entirely of thin sheet iron; and have consequently the advantage of parting with their heat very rapidly, instead of retaining the day's heat for a long period after sunset, as is the case with thick walls of masonry or brickwork. The result is found to be that the internal temperature after sunset is maintained either exactly coincident with the external temperature or within less than one degree of difference, whether the external temperature happen to be falling or rising during the night. The observatory is consequently ready at once for use in the evening, without the usual delay before the heat of the day has been dispersed and the interior of the building has become cooled down to the temperature of the external air. Suitable doors are provided in the flat and sloping parts of the roof, and in the side walls, giving a complete range of observation from the zenith to the horizon; and the whole building, including the sides, is mounted upon rollers running on a circular rail, and is rotated with the greatest ease by means of a hand-winch and pinion, gearing into teeth cast on the rail. The height of the building is less than in the ordinary construction, where the top only is made to revolve upon the walls, and where the telescope has accordingly to be centred above the

level of the walls for obtaining horizon views; and an octagonal shape is adopted for advantage of construction and appearance in wrought-iron. The telescope is mounted on a central pillar, bolted down upon a stone and brick pier, which is isolated from the joists and boards of the floor, so that the telescope is kept entirely free from vibration.

KRUPP'S 12-IN. COAST GUN.

THE 30½-centimetre (12-in.) gun, mounted on a carriage for coast defence, was exhibited in the Krupp Pavilion of the Vienna Exhibition. The following are its principal dimensions:

Calibre	12·007 in.
Length of gun	21·982 ft.
" bore.	18·930 "
Weight of gun with wedge . . .	36·6 tons

The gun has 72 parallel grooves, with ·1771 in. width of bands, and a uniform twist of 71·477 ft. in length:

The weight of charged steel shell is . .	651·2 lb.
" " charge (prismatic powder, .	132·
Initial velocity	1525 ft.
Weight of common charged shell . .	565 lb.
" charge (prismatic powder) .	110 "
Initial velocity	1508 ft.

The carriage is intended for earth parapets 6 ft. 3 in. high, and has a height of 7 ft. 8 in. To check the recoil an hydraulic buffer is used. The running out of the gun after discharge is self-acting.

The projectile is lifted by means of a movable crane with windlass, which is arranged on the right-hand side of the slide, and brought on to the bottom of the gun. The elevation, ranging from +17 deg. to −7 deg., is effected by means of a toothed elevating arc on the upper part of the carriage. For training, the end of the slide is provided with a chain gear. By this apparatus the gun can be very easily and quickly served. To run in the gun, a rope windlass may be placed, if necessary, on each side of the slide behind.

The weight of the carriage is	5·650 tons
" " slide	15·350 "
Total	21·000 "

A 12-in. gun of this class was tried in February last, in the presence of a commission of Prussian and Austrian officers, with

5	rounds of	44	lb. of prismatic	powder
7	"	88	"	"
6	"	110	"	"
207	"	132	"	"
5	"	143	"	"

The projectiles were solid shot, weighing from 660 to 671 lb. The gun after this trial was found uninjured, except for some slight channelling in the chamber. The carriage was also uninjured excepting a very trifling crushing of the points of the wedge rails in the guides of the slide.

THE 35-TON STEAM HAMMER.

On a vacant piece of ground to the south of the Royal Gun Factories in Woolwich Arsenal, is the framework of three large iron structures, which, when finished, will form a very important addition to the gun factories; one of them will contain a 35-ton Steam Hammer; another will be fitted as a rolling mill; whilst the third will form a boiler house. The building for the steam hammer will be 150 ft. long by 100 ft. wide; the rolling mill will be of the same dimensions; and the boiler house will be 100 ft. square. The steam hammer, when erected, will be one of the largest and most powerful yet constructed, and it of course necessitates a special arrangement for the bed plates—for there are several—of the anvil block and their foundations. The whole of these are of a very massive and solid character, and consist in the first place of a hundred 12-in. square timber piles, arranged at equal distances apart in the form of a square, 30 ft. by 30 ft. Around and between the piles for a depth of 4 ft. from the heads is a bed of concrete, which extends several feet beyond them on each side. Upon the piles is laid a cast-iron plate 11 in. thick, and weighing 164 tons. This plate is in three portions, and is put together with joggle joints. On this plate is a double layer of 12-in. oak baulks, the upper layer being placed at right angles to the lower one. Upon these oak baulks comes a second plate of cast-iron 10 in. thick, and weighing 121 tons. This plate is cast in two pieces, and covers an area of 27 ft. by 27 ft. Then comes a 2-ft. thickness of oak timber, consisting of baulks placed with the grain vertically or end on, the collection of baulks being held together by an iron strap 6 in. deep by 2 in. thick. These baulks carry a third cast-iron plate 12 in. thick by 24 ft. square, and weighing 116 tons. Upon this will come a fourth plate, 12 in. thick by 22 ft. square, and weighing 100 tons, a thin packing of oak, just sufficient to prevent contact, being interposed between the two plates. On the top of the last plate will come another thin oak packing, and then the round anvil block, which weighs 102 tons, and is 3 ft. 4½ in. deep, 15 feet in diameter at the base, tapering to 12 ft. at the top. Upon this will come a cylindrical cast block, 2 ft. 8 in. deep and 12 feet in diameter, which will weigh between 60 and 70 tons, and will carry the movable anvil blocks, which will be of various sizes to suit the work to be done.—*Engineering*.

HOERDE IRON WORKS.

The Hoerde Iron Works, near Dortmund, in Westphalia, were the first large works erected in North Germany after a Scotch pattern, and founded in 1852, with a capital of 300,000*l.* by a joint-stock company, and this has gradually increased to 600,000*l.* as the works became more and more extended. With this outlay, iron works, containing blast furnaces, forges and steel works, collieries and iron mines, have been acquired, valued June 30, 1872, at 1,283,700*l.*, of which sum, however, over 450,000*l.* have been refunded, so that the company's property stands only charged with a value of 888,400*l.* in their books. The works contain 8 blast furnaces, which will produce about 62,000 tons of pig iron annually; one of them has been in blast for twenty years without interruption. Three furnaces produce Bessemer-steel iron exclusively from a mixture of carbonates, brown and red hematites, with 42 per cent. of limestone, and about 1·5 ton of coke per 1 ton of Bessemer pig, whilst for white forge pig the quantity of coke consumed is from 1·2 to 1·3 per ton. The iron ores are derived from a great many localities besides those from the company's mines, and a well-furnished chemical laboratory has plenty to do in investigating the qualities of all the ores and the iron and slag produced. The blast is provided by 2 horizontal engines of 96 in. diameter and 6 ft. stroke, 2 direct-acting vertical, and a colossal Hentschel beam engine. The forge and mill of Hermannshütte produce principally rails, tyres, heavy T and girder iron for bridges and architectural structures. The train of rolls for rails and heavy irons is three high, and is driven by an 800-horse power engine, whilst the tyres are rolled without welding, between vertical rollers. A speciality of the works are wrought-iron disc wheels for railway carriages, which are made by a combined process of rolling and hammering, and are turned out in considerable quantities.

The Bessemer steel works are stated to contain four converters after the English principle, and produce about 15,000 tons of steel per annum. The works have always paid a dividend to the shareholders, though they had to pass through a very bad business period, and the average return has been 8·5 per cent. The annual consumption of coal is about 350,000 tons, of which quantity more than one-half are raised in the mines of the Company.

ENGLISH WATCH-WORK.

An interesting, though small, Exhibition of English Watch-work has been on view at 39 Northampton-square, the house of the British Horological Institute, a society which has been formed for the purpose of maintaining the old pre-eminence of British watchmaking, and of assisting British watchmakers to hold

their own against foreign competition. It is under the presidency of Mr. E. B. Denison, Q.C. It has also furnished a channel through which Lady Burdett Coutts, with her customary wise liberality, has given prizes for the best essays on subjects connected with the craft; and it aims generally at the more complete training of the men by whom the different parts of watches are actually made and put together. Of late years the supply of watches to the public in this country has fallen almost entirely into the hands of middle men, who are erroneously called watchmakers, who have shops in the leading thoroughfares, and who, as a rule, know nothing more about watches than where to buy with advantage. These middlemen are the successors, and sometimes still trade under the names, of men who were veritable watchmakers in times gone by, and whose shops were legitimate appendages to their manufacturing establishments. In most cases, however, such a connection has long ceased, and the shopkeeper simply intervenes between the maker and the purchaser, absorbing and appropriating the credit due to the former and enormously increasing the sums paid by the latter. The Institute seeks to bring the actual watchmaker once more before the public.

The present Exhibition is intended to fulfil the several purposes of giving prizes for the best work, of bringing the actual doers of that work into their rightful prominence; and of placing the work itself under the observation of the members of the trade, so that it may furnish them with an example and a stimulus. Three judges were appointed—one by Lady Burdett Coutts, one by the Council of the Institute, and one by a ballot among the exhibitors; and these judges were Sir Charles Wheatstone, Mr. V. Kullberg, and Mr. J. M'Lennan. A silver medal and prizes ranging from *5l.* to honourable mention were given as rewards for excellence. The competitors were not numerous, for the whole exhibition was contained in a front room of the house in Northampton-square; but the specimens shown were mostly of great merit. The first prize—a silver medal and *5l.*—has been awarded to G. Abbott for the best chronometer escapement, and the second prize of *5l.* to J. E. Tilling for the best lever escapement. R. Bridgman received *3l.* for a lever escapement of great merit, and W. Smith, of Coventry, received honourable mention. In all these escapements the delicacy of the work, the truth and parallelism of the surfaces, and the perfection of the finish, have never been surpassed, and required the aid of a magnifier for their full appreciation.

For the best watch-finishing the first prize of *5l.* was awarded to R. Gore, and a second prize of *2l.* to W. C. Smith, an apprentice 18 years of age. The exhibitors of keyless mechanism were so nearly on a level that no prize was awarded to any of them, but honourable mention to all. This decision was, perhaps, partly due to the fact that keyless watches, although they have of late years been very fashionable, are at a

disadvantage as regards the attainments of the highest time keeping excellence.

The *5l.* prize for an applied balance-spring was given to G. Morton, who was also a maker of the wire from which the spring is constructed, and who exhibited a card of balance springs, one of which is of almost inconceivable minuteness. A prize of *5l.* for the best gold case was taken by Andrews, in whose work the joints are so closely fitted as to seem absolutely impenetrable by dust; and it is remarkable that several of the *5l.* prizes fell to the workmen employed by a single manufacturer, Mr. Glasgow, who is thus entitled to be called a first-class watchmaker in the true sense of the words.

Besides the specimens sent in to compete for prizes, the Exhibition contained a few things shown only as curiosities. Among these was a very elaborate second-hand watch, entirely made by hand filework; and a thin sixpence which has been drilled through from edge to edge, by a hole just large enough to admit the passage of a single human hair.

There are other matters in the Exhibition well worthy of notice, among them an interesting collection of enamelled dials by Twitchings, and an ingenious measuring tool by Bridgman. Both of the latter received honourable mention.—*Times.*

FIRE-PROOF PAINT.

Although the difficulties are so great that they are practically insurmountable, of constructing buildings adapted to general uses in such a way that they shall be fire-proof, it is a fact that the means which do present themselves of reducing the chances of conflagration are not sufficiently employed.

We would not refer so much to great public buildings, such as the Alexandra Palace, where the means for subduing a fire, should it break out, are supposed to be perfect; but to the dwellings, shops, and warehouses of great cities, which are exposed constantly to the danger of fire, and in which the commonest precautions are too often neglected. Such buildings cannot, as a rule, be constructed "fire-proof;" but they can at least be greatly protected by the application of fire-proofing materials, which may take the place of common paint, and while they serve to preserve structures from decay, add immensely to the power of resistance against fire. One of the most remarkable, and certainly a most successful material of the kind we mention, is that long ago introduced by Mr. Frederick Ransome, better known, however, in connexion with artificial stone than silicious paint; although this latter should find a far more general application than the former. The composition of the paint is analogous to that of his artificial stone; that is to say, it consists principally of a mixture of pure silex and soluble silica, which is laid over the surface to be protected, and covered afterwards by a second coating of chloride of calcium, which

converts the paint into an impervious coating, effectually preventing the penetration of damp, and to an extraordinary degree resisting the action of fire.

Its application has thus a double advantage, as it necessarily acts as a preservative material, protecting woodwork from decay. We have already noted in these columns the wonderful power of resistance possessed by this paint, as exemplified by the destruction of a light timber shed filled with inflammable materials and ignited, the shed having been partially covered with protecting felting, and partly with Ransome's paint. After the fire had been extinguished it was found that the fire which had acted from the inside of the building, and had charred the wood on the underside of the roofing, had been successfully resisted by the paint on the outer side, which was undamaged, and which had protected the wood for a depth of a quarter of an inch.—*Engineering.*

PROTECTION FROM FIRE AND BURGLARS.

AT the north end of Queen Victoria-street, by the Mansion House, is a triangular piece of ground whereon the premises of the National Safe Deposit Company have been erected, and which in the first instance had public attention called to it from the builders having laid bare a portion of the course of the Old Wall Brook, and brought to light some unique specimens of ancient pottery, as well as a few gold trinkets, and a considerable number of bones, probably of Saxons, Romans, and Ancient Britons. So deep did the excavators go that they reached the London clay, where they put a thick bed of concrete and flagged it as a sub-basement to the building. It is to cost 30,000*l.*, and will cover an area of 6,500 superficial feet. Although the architectural effect of the superstructure will be equal to anything in the neighbourhood, that which is below the surface is, perhaps, the most important, as it is to be made as far as possible fire-proof and burglar-proof, the Company having been formed to take charge of bullion, plate, &c., guaranteeing their safety, at a certain tariff of assurance. The basement and sub-basement are divided into rooms, each containing four ranges of safes with a gaslight in it burning both by day and by night; partly to ventilate it and keep it dry, and partly to enable the day or the night watchmen to inspect it through a peep-hole as they take their rounds through the galleries, the number of their visits and the times of them being recorded by an automatic apparatus with clock. The walls are built of fire-proof Staffordshire bricks a yard in thickness, with an inner shell of chilled steel 3 in. thick. The whole is enclosed in an outer wall of Sussex bricks 10 ft. thick. The stories above the ground floor will be used as offices.—*City Press.*

CANADIAN PLUMBAGO.

ONE of the most valuable products of the mineral kingdom is certainly Plumbago, and this is owing to its comparative scarcity. The principal source whence it has been obtained in this country is Cumberland, where are situated the well known mines of Borrowdale, which at one time yielded their proprietors 100,000*l.* in a year, the ore selling at 45*s.* per pound. But times have changed, both with regard to the yield of the ore and the price obtainable for it, these once celebrated mines being now practically exhausted. Plumbago is found at Glenstrathfarrar, in Inverness, and at Craigman, in Ayrshire, as well as in Cornwall, but in either case only in comparatively small quantities. Deposits of plumbago occur at Arendal, in Norway, and also in Findland and the United States; but the chief source of the present market supply is Ceylon and the East Indies, the Ceylon plumbago being a very high standard. There is, however, at the present time, a great scarcity in the supply of plumbago, the crucible manufacturers absorbing very considerable quantities. In view of this, therefore, it is satisfactory to find that some extensive deposits of this mineral have been discovered in the township of Buckingham, about eighteen miles to the north of Ottawa, the capital of the Dominion of Canada. The mines, which have been opened, are situated on the River de Livière, a tributary of the Ottawa, and are favourably placed both as regards the working of the ore and its transport. A recent examination of these mines made by Mr. George Henwood has disclosed the fact that there are fourteen well defined lodes, in which plumbago of unusual purity occurs in large quantities. Several of the lodes intersect each other, and the mineral in some of them varies in thickness from 6 to 10 ft. Besides this there is a quarry of disseminated ore, over a quarter of mile in length, and 70 ft. in height, producing a very good percentage of plumbago. The specimens of the mineral taken from the lodes by Mr. Henwood are exceedingly rich in appearance, and are remarkable for their crystalline formation and purity. They display all the varieties of the ore, some being columnar and reticulated, and others laminated. One specimen measures 2 ft. in length, 16 in. in depth, and about 5 in. in thickness. Assays of this ore, made by Messrs. Johnson and Sons, show it to contain 97 per cent. of plumbago, the minimum annual yield of which the lodes are capable being estimated by Mr. Henwood at 5,000 tons, whilst twice that quantity, it is stated, can be obtained annually from the workings in the quarry. The produce of these mines is said to be preferred before the best Ceylon ores, and to command a higher price in the local markets. From the appearance of the samples, and the extent of the deposit in which they occur, we may infer that this discovery will, in its results, exercise an important influence upon the market.—*Engineering.*

THE RE-ARMAMENT OF THE FLEET.

The successive growths of our ironclad fleets from 4½-in. iron clothing to 6-in. armour, and thence to 8-in. and 12-in. plating, has brought with it a corresponding gradation of ordnance. As a necessary consequence of this gradual increase of armour and weight of guns, the armament of the fleet has got into a very confused state. As the 6½-ton gun era corresponds with the 4½-in. and 6-in. armour period, ships with those thicknesses of plating remain armed with that comparatively small weapon. Whilst the 8-in. and 16-in. armour synchronises with the period of the 12½-ton and 18-ton ordnance, ships so protected are armed with weapons of these weights. Now that 12-in. plating protects more recent vessels, 25-ton and 35-ton guns come into being.

Were it possible to do so, it would evidently be most desirable to re-armour the whole fleet, so as to bring the defensive value of the elder ships up to that of the later vessels. That, however, is, we need hardly say, impossible. The structural improvements which enable the architect to concentrate a greater weight of armour upon a smaller portion of the hull, could not be introduced into existing ships. No such difficulty, however, obtains as to concentrating the weight of ordnance into fewer guns. Beyond certain alterations of the ports, and strengthening of the decks, no insurmountable obstacle exists to replacing the 6½-ton gun by the 35-ton gun, provided the gross weight of armament be not greatly increased. As to working the 35-ton gun on the broadside, all the mechanical difficulties have been successfully overcome by Captain Scott. His carriage for the 25-ton broadside gun enables that weapon to be readily worked at sea by four men; and doubtless, by his mechanical appliances, 35-ton guns will be worked more easily and safely by fewer men than the existing 6½-ton guns, which have not yet been furnished with his mechanism.

There are, then, no great difficulties in the way of that re-armament of the fleet which thoughtful naval men so urgently desire, and which *Fraser's Magazine* so strongly advocates.

The *Royal Alfred*, though an old wooden ironclad, carries one ton of ordnance to every 36 tons of ship. Taking that proportion as the standard of comparison, it will be seen that all the ships subsequently built carry less armament and more armour. But it is not so much to the weight of ordnance carried as to its faulty distribution that we wish now to refer. Take, for example, the following ships:—

	Tons of ordnance carried	Pieces
Minotaur	193	26
Agincourt	218	28
Northumberland	261	28

	Tons of ordnance carried	Pieces
Black Prince	192	28
Warrior	195	20
Bellerophon	145	13
Royal Alfred	177	18
Royal Oak	166	24
Zealous	130	20
Vanguard	139	14
Hercules	195	14
Sultan	194	12
Monarch	131	7
Devastation	140	4
Glatton	50	2
Hotspur	32	3

In the day of battle it will be utterly impossible for seamen to single out foes armoured with precisely similar plates to those of their own ship. Nor, if a choice of foes were possible, would a thick-plated *Devastation* single out a similar vessel for a couple of hours battering when, by a brief effort, she might sink a *Zealous*, and discourage the hostile fleet. But if the guns of the *Zealous* were as capable of perforating the *Devastation* as that ship's guns are of riddling the *Zealous*, then the latter vessel might make a good fight for life, and who, considering the chances of battle, would venture to say that the odds would be overwhelming if she carried the British flag. What, however, *Fraser's Magazine* contends for, is not that thinly-plated ships would ever be equal to the more thickly-armoured vessels, but that the former vessels should be given a fair chance in battle by carrying weapons which would perforate the thickest armour afloat.

It will be many years before the earlier built ironclads cease to exist; and should a maratime war intervene these vessels must fight whatever hostile ships they may fall in with. It is not the custom of the sea for opposing ships to exchange information as to thickness of their armour before commencing an action; and if otherwise known to be greatest on the enemy's side, why must the *Northumberland*, a British ironclad of 10,584 tons weight, be compelled to run away? The British ship has now no other expedient, because her guns are of an obsolete weight. Let her 28 pieces, weighing together 261 tons, be changed for 8 pieces of 280 tons, and then the *Northumberland* may be fairly expected to try the fortune of war with a hostile *Devastation*.

Though there is no way of furnishing guns with adequate destructive power without increase of weight, yet it is unfortunate that British ordnance should have, in the words of the late Ordnance Select Committee, "decidedly the lowest velocities." For, as striking force varies as the squares of the velocities, it obviously follows that British rifled guns have necessarily

"decidedly the lowest" perforations. This loss of velocity, and consequently of striking force, increases with the weight of the projectile to be rotated, as might naturally be expected when it is remembered that the rifle bearing which both supports and rotates the shot is the same whether the shot be 115 lb. weight, or 700 lb. in weight. The 35-ton gun is necessarily the greatest loser from this cause. The increased loss of perforation, in the case of the 35-ton gun, may be understood by comparing its performances with those of lighter guns similarly rifled. Thus, a 6½-ton gun yields a "penetrating figure" of 85 foot tons per in. of its 7-in. 115-lb. shot's circumference. By doubling the weight of the gun and shot, the "penetrating figure" becomes about one half more, *i.e.* a 250-lb. shot issues from a 9-in. 12½-ton gun with a striking force of 125 foot-tons per in. of its circumference. Doubling the weights of both once more, the "penetrating figure" increases as before to about one-half more, *i.e.* a 12-in. 600-lb. shot issues from a 25-ton gun with a "penetrating figure" of 188 foot-tons per in. of its circumference.

Again, a 9-ton gun yields a "pentrating figure" of 100 foot-tons per inch of its 8-in. 180-lb. shot's circumference. By doubling these weights the "penetrating figure" is increased two-thirds, *i.e.* a 400-lb. shot issues from its 10-in. 18-ton gun with a striking force of 166 foot-tons per inch of its circumference. But when these weights are doubled once more, only one-third higher "penetrating figure" is attained, *i.e.* a 700-lb. shot leaves a 12-in. 35-ton gun with a striking force of 220 foot-tons per inch of its circumference. instead of 277 foot-tons if it rose two-thirds, or 249 foot-tons if it rose one-half. That is to say, if the 35-ton gun followed the law of increased perforating power which obtains by doubling the weights from the 9-ton gun upwards, it would perforate 21 in. of armour with service backing; and if it followed the law which obtains by doubling the weights from the 6½-ton gun upwards, it would perforate 19 in. of backed armour, instead of 17 in. as at present.

Even supposing that having "decidedly the lowest velocities" only involves the loss of 2 in. additional armour perforation in the 700 lb. shot, this would not be a light loss in the day of battle. But the armament of the *Northumberland* and her consorts needs not only an accession of velocity, but an accession of weight in the projectile, and hence the necessity for the employment of heavier ordnance.

The only grave objection to this re-armament of the British fleet is stated by *Fraser* to be the great loss of endurance which the present rifle system gives rise to in the heavier guns. Naval men are alarmed at the idea of resting the safety of the fleet and the security of the country solely upon an armament of 35-ton guns. They observe that the only gun of that nature tested so far, gave way after 38 horizontal discharges with mild pebble powder, spread over three and a half months; and that those

furnished to the navy have only been proved by firing, at long intervals, three reduced charges horizontally. Practical gunners are of opinion that if such guns were, after a few years ordinary training practice, taken into a naval bombardment to fire 20 elevated rounds per hour, they might fairly be expected to break down during the first hour. That is to say, that the strains to which the "Woolwich Infants" would be subjected during a naval bombardment would be about twice those under which the late "Infant" succumbed when carefully "nursed" at Woolwich.' This is the only serious objection to the re-armament of the fleet. It is one strongly felt by the navy, and the opinion of the navy on a point of that kind cannot be lightly disregarded. Indeed, it is generally understood that this lack of endurance in the heavier guns is the only cause that the armaments of the fleet are suffered to continue in their present obsolete condition. Without some such good reason, the Ordnance Department of the Navy would be deserving of severe reprobation for allowing the fleet to fall into its present low artillery condition.—We quote the above from *Engineering*.

AN AMERICAN TORPEDO BOAT.

A Torpedo Boat, which has been designed by Admiral Porter, and the construction of which occupied a year, has been launched from the United States Navy Yard at Brooklyn. The boat resembles a cigar, being of narrow beam with a tapering bow. She has been built of iron, 170 ft. long, 28 ft. beam, and 12 ft. deep, her burden being 800 tons. The vessel, without her machinery, weighs 527,000 lb. She is to have compound engines of 200 horse power. She is divided into compartments, with a double bottom, having pumps and valves so arranged as to settle her in the water to the level of the deck. She has a torpedo spar projecting from her bow, and three similar spars on either side. Strength and speed, with the ability—by means of the Fowler paddle-wheel—of turning within her own length, have been the objects chiefly aimed at in her construction. The torpedoes are to be attached to an enemy's ship, and are to be exploded by electric agency.

NEW BREAKWATER.

A Breakwater has been proposed to be formed at Madras, of which the cost is reckoned at one million and a third sterling. The western side of the Bay of Bengal is singularly deficient in good harbours, and the heavy surf makes commerce difficult without them. But why not try seaweed harbours? The trumpet-weed at the island of Juan d'Acuna rises to the surface from a depth of 60 ft., and a belt of such seaweed would constitute as good a breakwater as could be constructed. The energy of the waves would be expended in the friction produced

by the rising and falling of the water among the weeds, instead of being expended, as at present, in breaking upon the shore.—*J. C. Bourne.*

IMMERSION OF SCREW-PROPELLERS.

Professor Osborne Reynolds has read to the British Association two papers, one "On the Effect of Immersion on the Action of the Screw-propeller,' and the other "On Friction in Rifled Guns.' In the first he showed that when a screw was once fairly down beneath the surface, depth of immersion was of no importance. The object of the second paper was to show that the friction between the studs and the grooves necessary to give rotation to the shot consumed more work with an increasing than with a uniform twist, and that, in the case of grooves which develop into a parabola, such as those in the Woolwich guns, the waste from that cause was double what it would be if the twist was uniform.

TUNNELING MACHINERY.

There has been read to the British Association a paper interesting at the present time, when engineers are seeking to break down the barriers which separate country from country; and tunnels, whether under the ocean or through mountain ranges, are projected, or are in course of construction. The Burleigh rock-drill, driven by compressed air, was described in a paper by Mr. Plant, and the machine in actual operation was shown in a yard adjoining the Section-room. The principal feature of the machine is that it imitates the action of a quarryman in boring a hole in the rock. A jumper, an inch and a quarter in diameter, making from 200 to 300 strokes per minute, is driven into the rock, the difference between it and the action of the quarryman being that the jumper is infinitely more powerful and regular in its stroke. It also rotated and cleared itself as it proceeded. The transmission of power by means of compressed air, involved in the working of all these machines, was discussed at considerable length by Mr. Bramwell, Mr. Siemens, and others; and though it would appear that transmission of power by means of water was attended by less loss, yet that, for the special circumstances under which such machines would have to be worked, air was the better vehicle for the purpose. Brain's system of mining by means of boring machinery, dynamite and electric blastings, came under discussion, and was followed by a paper by Mr. Gott on the Bradford water-works, the details of the construction of which were of great interest to the profession.

PRESSURE LOGS.

Experiments with reference to what are termed "Pressure Logs," for measuring the speed of ships, under consideration of a Committee of the Association, came before the Section, and

Mr. J. R. Napier, the Rev. E. L. Berthon, and Mr. A. E. Fletcher, respectively described, by the aid of diagrams, the methods they adopted for the application of the principle.

It is understood that actual trials have been made with the three instruments which have been placed at the disposal of the Committee.

DEFENSIVE POWER OF SHIPS' ARMOUR.

THE important subject of the defensive power of the Armour applied to our Ironclads in resisting the penetration of shot is again attracting much public attention. In some experiments lately made in Germany the 10-inch gun sent shells completely through a structure consisting of a 12-inch plate backed by 18 in. of timber, and the rear of the target was strewn with jagged débris, forming a shower of destructive projectiles. Several years ago the late Sir Howard Douglas maintained the opinion that, instead of trying to make vessels shotproof, it would be wiser to expend our money in providing more powerful guns; and for some years past we have been insisting upon the folly of constructing professedly shotproof vessels which were either not shotproof at all at the time of their construction, or which, even if shotproof then, did not allow any margin whatever for that increase in the power of ordnance which is continually going on. We have long maintained that broadside armour-clads are an absurdity, as a broadside armament implies a large area of target; and this in its turn implies thin armour, which could not be expected to keep shot out. We consequently advocated the *Monitor* model as the only one which permitted the necessary thickness of armour to be employed without inordinate dimensions. Six years ago we maintained that 18 in. of side armour backed with 4 ft. of oak, and a turret 24 in. thick of solid iron, represented the minimum defensive strength which it would be advisable to employ, and we added that this strength might probably continue sufficient for ten years. The *Devastation* is an imperfect approach to these ideas. But we indicated that, as the *Monitor* system was a system of concentration, there should be only one turret in each vessel, as it was preferable to utilise the displacement required for the second turret in increasing the thickness on armour, the power of gun, or the power of engine, or all of these conjointly, than to attempt to carry many guns in each vessel—number, in fact, being only another expression for weakness. It would appear that these ideas are at length beginning to penetrate the official mind. But in its perceptions it still lags behind what was proper to be done six years ago, and what was then sufficient is not so now. We have many times stated that, with the existing strength of materials available for the construction of ordnance, there were two expedients by which the penetrating power of the projectiles

could be increased—one by the use of piston shot and the other by the use of the rocket shot; or the two expedients might be combined. But besides these secrets of increased power, another is now offered to us in the use of a stronger material. We long ago intimated that we saw no reason why wrought-iron guns should not be cast under great pressure, on the Rodman principle of cooling from the centre; and in the Whitworth compressed iron and steel guns, cast under great pressure, we have an approximate realisation of this idea. We do not think, as some do, that armour should be given up. But the exposed area should be small and the thickness great. Effectual precaution should also be taken against submarine shot, and our ironclads should be constructed below the 'tween-decks on the principle of a diving-bell, so that they would not sink even if their bottoms were out altogether. At the present moment we stand in this position, that a single *Monitor*, constructed according to the indications given above, could sink the whole of our ironclad fleet in detail, while the assailing vessel would be itself impregnable against any power of offence which we should be able to employ.—*Mr. Bourne's Scientific Results, in the Illustrated London News.*

PHOSPHOR-BRONZE.

About two years ago were published in *Engineering* a series of articles, giving a detailed account of the experiments of Herr Wöhler on what he aptly termed the "fatigue of metals," these experiments having reference to the effects on iron and steel of repeated applications of strain. Recently there have been conducted, at the Royal Academy of Industry at Berlin, a similar series of experiments with various kinds of Phosphor-Bronze; and these experiments, which have been carried out by order of the Royal Prussian Ministry of Commerce, have afforded results which we may record here, as they are not only of interest in themselves, but may be compared with those obtained by Herr Wöhler when experimenting on iron and steel.

The first bar of Phosphor-Bronze was tested under a tensile strain amounting to 10 tons per square inch, and it withstood 408,230 applications of this strain before fracture. A bar of ordinary bronze failed to withstand the application of a strain of 10 tons per square inch at all. A second bar of Phosphor-Bronze was tested by repeated strains of 12½ tons per square inch, and actually withstood 147,850 applications of this load.

Other experiments were made by placing bars of Phosphor-Bronze in a machine in which they were subjected to transverse strains, 40,000 deflections or applications of load taking place per day. In this machine a bar of Phosphor-Bronze, while subjected to a strain of 10 tons per square inch, withstood 872,980 deflections, while the best gun metal failed after 102,650

deflections. Another bar of Phosphor-Bronze, under a strain of 9 tons per square inch, was still being tested at the date of the report we have received, and it had, up to that time, withstood 1,260,000 deflections without failure. These facts are very interesting, and point to the great endurance of the material.—*Engineering.*

THWAITES AND CARBUTT'S STEEL TILTING HAMMER.

A 700 cwt. Steam Hammer has been exhibited at Vienna by Messrs. Thwaites and Carbutt, of Bradford. It has been specially constructed for tilting steel, work which requires the blows to be delivered continuously in very rapid succession, rather than slowly and heavily, as with ordinary hammers. This machine is intended to deliver (with steam having a pressure of 60 lb. per square inch) as many as 400 blows per minute, but its ordinary speed will probably not exceed 300 blows. In order to work at such a speed, it has been necessary to make the hammer self-acting, but it is so constructed that it can also be worked by hand if required. The hand lever behind the framing regulates the length of the stroke through a triple-ported piston valve. This lever can be used for working the hammer by hand, but under ordinary circumstances it is made fast in the position corresponding to the desired stroke, and the bevelled slot in the front of the tup opens and closes the valve at the right time. The two levers in front of the framing are connected with two piston valves in a separate casing, which regulate the amount of steam allowed to pass through the main valve to the two ends of the cylinder, and in this way determine the force of the blow. The piston and rod are of solid steel.

HIGH-SPEED STEAM HAMMER AT THE VIENNA EXHIBITION.

MESSRS. G. BRINKMANN and Co., engineers, of Witten-on-the-Ruhr, Westphalia, are well known on the Continent for the manufacture of high-speed Steam Hammers: it is therefore of interest to see some of their work exhibited at Vienna, namely a double-acting hammer with single frame and a double-acting hammer with double frame. Both these hammers are used for tilting iron or steel, but the former has a constant stroke whilst that of the latter is variable. The anvil bed or stock is used as bedplate for the hammer, an arrangement which is adopted generally by these manufacturers for high speed hammers, except in the case of tilting hammers for steel, the anvils of which are, without exception, made independent of the bedplate of the hammer.

Another peculiarity of the construction, deserving of special mention, is the mode of fastening the cylinder and of the guide bars to the standards, which is not effected as usual by means of bolts, but by wrought-iron rings shrunk over circular projections, one half of each of which is cast to the cylinder or

guide bars respectively, whilst the other half forms part of the standards; when the latter and the cylinder and guide bars are respectively fitted together correctly, these projections form circular discs over which the wrought-iron rings are shrunk.

The hammer is worked by two levers, enabling the admission of the steam to be regulated, whilst the other is used for altering the stroke and the force of the blow. The lever for regulating the admission of the steam can be fixed at any position, and its lower end is connected with a second lever, to which a rod for the working of the admission valve is attached. The one end of the lever for the alteration of the stroke can be fixed at various positions, by a spring and a notched segment, whilst the other end is fixed to a short shaft passing through the side bracket of the cylinder. From the back view of the latter it will be seen that this short shaft, which is cranked on this side of the hammer, carries a double lever, the two ends of which are connected with the valve rod and the valve gear respectively. The latter consists of a lever fastened to the ram, and a rod connecting this lever with one end of the double lever.

The admission of the steam into the cylinder is regulated by a piston valve, the position and travel of which depend upon the position of the cranked part of the shaft passing through the side bracket of the cylinder. It is evident, therefore, that any position of the lower end of the long lever in the notched segment must correspond with a certain position of the cranked part of the horizontal shaft, and thus also with a certain position and travel of the piston valve, upon which the stroke of the piston depends. The exhaust steam passes back again through the piston valve, and thence from the steam chest through a short tube into the top side of the standard, from whence it escapes into the exhaust pipe.

The weight of this hammer is 8 cwt., the cylinder has a diameter of 11 in., and the longest stroke is 18·5 in., allowing of forging iron pieces 6 in. to 7 in. high, and steel pieces 5in. high. The average number of blows per minute is 200, and the whole hammer, with bedplate and anvil, weighs 8 tons; without the two latter 3 tons 17 cwt. The distance between the two standards at the bottom is 4 ft. 5 in., whilst the total height of the standards from the bedplate is 7 ft. The piston rod is made of crucible cast steel, has a diameter of 5½ in., and is formed in one piece with the piston and ram, whence the cover of the cylinder has to be made in two pieces. This hammer has been working at the Exhibition, and the adjustment of the stroke and of the blow has been shown to be very readily effected. We should mention, in conclusion, that the workmanship of the hammer is very creditable to the manufacturers, who are building hammers on this system up to 7 tons.—*Engineering.*

BRACKET RAILWAY CHAIRS.

A PAPER has been read to the Institution of Mechanical Engineers, describing the new "Bracket Chairs for suspending Double-headed Rails on the West Cornwall Railway," by Mr. James D. Sheriff, of Truro. These chairs are each made in two separate halves, fixed one on each side of the rail, the bearing of which is on the under side of the upper head; and there is no portion of the chair underneath the bottom of the rail, which is suspended by the head, with the bottom just clear of the sleeper. When turned over, therefore, after the top face has been worn out, the bottom head of the rail presents a perfect face altogether free from the injury that occurs in the ordinary chairs, in which the bottom face of the rail becomes more or less indented by bearing on the bottom of the chair. The two halves of the chair are secured together by a bolt passing through the rail, and fixed to the slipper by screwed spikes. On one side the spike passes through a slot in the chair, to allow that half of the chair to slide inwards when the spike is slacked, for removing or turning the rail; the slot is blocked by a washer, which fits in a recess at the end of the slot, and is kept down by the spike head. This chair, of which a specimen was exhibited, is believed to have been designed by Mr. Brunel in 1858, and introduced by him on lines in South Wales; it was afterwards adopted on the West Cornwall Railway, where it has now been in use for eleven years with complete success. In no case has the lower head of the rails when turned over been found to be injured; and the result has been thoroughly satisfactory as regards durability, safety, and economy of maintenance; there is an important saving in first cost, the bracket chairs being less than half the weight of the ordinary chairs. This construction is also free from the risk of a rail getting displaced by the loss or slackness of a key, and also from liability to fracture of the chair in driving the wood keys used with the ordinary chairs.

MERSEY RAILWAY TUNNEL.

THE promoters of the Railway Tunnel which is intended to cross the Mersey, the shafts for which have already been sunk, believed that they would have only a continuous mass of solid sandstone rock to penetrate. A paper has been published in the transactions of the Liverpool Geological Society for 1872, by Mr. T. Mellard Reade, C.E., of Liverpool, in which he contends that in all probability a deep gorge, filled up with clay or sand, will be met with, being the site of an ancient river or torrent formed in or before the times when England was covered with ice, and when its valleys were filled with glaciers. Mr. Reade believes that the ascertained data warrant the hypothesis, that before the boulder clays and other recent strata were laid down, a river draining the land now

drained by the Mersey flowed past Runcorn Gap, between land of some considerable elevation, to the sea.—*Nature.*

STEAM TRAMWAYS.

The Lisbon Steam Tramways have been described to the British Association, in an interesting paper by Mr. W. H. Barlow, Jun. These tramways are at present in operation between Lisbon and Cintra, a distance of about 15 miles, for the most part constructed on the existing roads for ordinary traffic. Two 9-in. broad longitudinal rails of wood are laid parallel to each other, nearly level with the surface of the ground. In the centre, between these two rails, was an iron rail of the double-headed pattern. The locomotives were similar to the small tank-engines in common use, with the exception that the centre or driving wheels had flat tires, 14 inches broad, instead of flanged ones. The guide-wheels were double-flanged, and ran on the centre rail only. The wheels worked on bogies, and were loose on the axles. In the carriages the arrangement of the wheels was precisely similar. This form of rolling-stock was found to be admirably adapted to sharp curves and comparatively uneven roadways. In some cases inclines of one in twenty were worked without difficulty, and the curves varied from three-quarters to two-and-a-half chains in radius. Mr. Bramwell remarked that it was a very encouraging fact to find that on the Lisbon tramways they had got railway carriages where the axles would not only radiate, but where one wheel was free to revolve on its axle. He considered that it was a disgrace to modern engineering that we should have two wheels rigidly fixed on an axle, and expect them to accommodate themselves to our requirements.

CONSTANTINOPLE TRAMWAYS.

The Report of the directors of the Constantinople Tramways Company for 1872 states that the Company's four original lines of tramways were in full work eight months before the period stipulated. There are 16,000 metres of tramway, and 5,000 metres of omnibus lines at present worked by the Company, or rather 13 miles in all. These lines were served last year by 64 vehicles. The number of passengers conveyed last year was 5,035,042, who paid 6,545,597 piastres. The present number of passengers ranges from 125,000 to 130,000 per week; and this number, it is expected, will increase when the fine season sets in to from 180,000 to 200,000. The Company's staff consists of 431 persons, exclusive of fore-runners. The return realised upon the shares last year was at the rate of 6 per cent. per annum.

WOODEN RAILWAYS.

THERE are upwards of 100 miles of Wooden Railway in operation in the province of Quebec (Canada). The gauge is 4 ft. 8½ in. The running time is about 16 miles per hour, but trains have been run at the rate of 35 miles per hour over these humble but useful lines. The rails are made of maple, 4 ft. by 7 in.; they are set up edgeways, and are notched into crossties 4 in. deep, and are held down by two wedges in the notch on the outside of the rails. The ties are 8 in. thick, and they are laid 20 in. apart. The cars have four wheels, and some of the engines used weigh 30 tons. In frosty weather the driving wheels have less adhesion than on metal rails, but no considerable difficulty is experienced from this cause. The rails will last from two to four years, according to the quality of the timber used, and the amount of traffic obtained and accommodated.—*Engineering.*

NEW ZEALAND RAILWAYS.

PLANT for a railway from Dunedin to the Clatha has been landed at Port Chalmers. It comprises eight carriages and four brake vans, besides a considerable number of trucks. There is to be a workshop at the Dunedin Station, and a quantity of machinery to be worked by steam has been erected. The revenue of the various lines now in operation in the province of Canterbury moved on in March and April at the rate of 100,000*l.* per annum. The railway contracts have been let in the province of Otago; the aggregate amount of these contracts was 474,628*l.*, and that of those obtained by Messrs. Brogden and Sons 371,616*l.* A contract was also let, during the financial year ending June 30, 1873, to the amount of 5,796*l.* on account of a bridge across the River Waitaki, the cost being equally divided between the provinces of Otago and Canterbury. Six contracts for sleepers to be used on the Otago and Canterbury railways were also entered into to the amount of 22,268*l.* Altogether, Messrs. Brogden and Sons would appear to have obtained contracts in the province of Otago to the very considerable amount of 798,259*l.*

RAILWAY SLEEPING-CARRIAGES.

A SLEEPING-CARRIAGE has been built for the North British Railway Company by the Ashbury Railway Carriage Company, of Manchester. It is 30 ft. long, and 7 ft. 6 in. wide, outside measurement, and is 6 ft. 10 in. high in the centre inside; at one end is a luggage compartment; at the other an ordinary second-class compartment, the central portion being devoted to the sleeping accommodation. This consists of two commodious saloons, which are each fitted with seats and beds for three first-class passengers. These saloons are connected by a lobby or passage, off one side of which opens a well-arranged lavatory, off the other a water-closet.

THE SOUDAN RAILWAY.

THE numerous cataracts which oppose insurmountable obstacles to the navigation of the River Nile, form barriers which now effectually cut off the fertile districts of Upper Egypt from communication with the outer world, and place a bar upon the progress and development of the richest territory belonging to the Khedive. To overcome these obstacles, and to open up a means of communication, has been for many years past one of the great objects of the Egyptian Government. An expedition was organised in 1857 by the late Said Mehemet Pasha to examine the obstructions of the Upper Nile, and to report upon the possibility of removing them, but it was quickly found that the cost involved in the work would be so great as to render it prohibitory. In 1865 Mr. John Hawkshaw was instructed to survey and report upon the first cataract, and to ascertain what would be the best means of overcoming this, one of the least formidable of the obstructions, and to extend the navigation as far as the second cataract. Mr. Hawkshaw recommended the construction of a canal and locks to skirt the cataract; the cost of this work was estimated at 250,000*l*., but the rock through which the cuttings would have to be made are of such exceptional hardness that no reliable estimate could possibly be made of the probable cost of the canalisation scheme. About the same time a general survey between Assouan and Khartoom was made. In 1871 the preliminary labours which had been undertaken assumed a more practical form, and Mr. John Fowler was instructed by the Khedive to prepare detailed surveys and estimates of the works necessary to complete the communications with the Soudan. Acting upon these instructions, a large staff was despatched to Egypt in 1871, and immediately commenced operations, which lasted during five months, and resulted in a complete survey of the country through which communications were required, and the collection of all the necessary data.

To overcome the obstacle to navigation presented by the first cataract, at which there is a difference in level of about 12·5 ft. at high, and 15 ft. at low Nile, Mr. Fowler departs from the proposal made in 1865 by Mr. Hawkshaw, and suggests a new and striking method of reaching the higher waters of the river from the foot of the cataract. He suggests the construction of a ship incline nearly two miles in length, on the right bank of the river, commencing at the bottom of the cataract between the island of Sehayl and the river bank, and terminating on the higher level in the harbour of Shalall, north of the celebrated island of Philœ. Rails would be laid upon the incline, and suitable carriages would be constructed to run upon them. The vessel to be raised or lowered would be floated upon these carriages or cradles, the ship and carriage being then drawn over the incline by hydraulic engines which would be driven by water at high pressure, pumped into huge accumulators at

the summit of the incline by a pair of large water-wheels, placed upon pontoons, and moored in one of the rapids of the cataract. A speed of from 4 to 7 miles an hour can be imparted to the vessel, according to the height of the Nile and weight of vessel.

The line, as laid out, commences at Wady Halfa, on the right bank of the Nile, which it skirts for a distance of about 160 miles, then by a bridge crosses the river and forms a chord 32 miles long to a small bend in the stream, which it again touches and follows on the left bank as far as Ambukol, at the 375th mile; then commences the stretch across the Bahiuda Desert, which terminates the line, after a course of some 550 miles.

In *Engineering* has appeared a series of sketches illustrative of the country through which the railway will pass. It is therefore sufficient to say that the engineering difficulties are comparatively small, that there will be no tunnels, and but little rock cuttings, expensive works being avoided by the curves and gradients adopted, the minimum radius of the former being 500 ft., and the maximum inclination of the latter 1 in 50. The bridge crossing at Kohé will doubtless be an expensive undertaking, and might be avoided by following the left bank of the river for the whole distance, while the nature of the bank would perhaps allow of a better line being laid out; but, on the other hand, the drift sand prevalent on the left bank as far as Kohé would make it difficult, if not impossible, to maintain the railway.

One of the special characteristics of the Soudan Railway is the gauge which Mr. Fowler has adopted—the same which Mr. Pihl has established with such great success in Norway. And in the choosing a narrow gauge for this important line, Mr. Fowler has not been guided by any estimates of probable insignificant traffic. On the contrary, the existing trade is considerable, and will be enormously developed when the line is made, as well along the banks of the Nile as in the Soudan itself, which, with inexhaustible natural resources, now lacks an efficient outlet for its produce. Grain, cotton, sugar, and all the varied animal and vegetable products of a tropical region, will be the staples descending the railway towards the north, whilst the return traffic will consist of machinery, fabrics, tools, and, generally, the mixed freight required by a producing isolated territory.

Moreover, it is not anticipated that the Soudan Railway shall be simply a local line, built to connect the Soudan with Upper Egypt, but that ultimately it shall form only one link of a great through railway, extending to Massowah on the Red Sea, and opening an alternative and more direct route to India and the East. By establishing a service of steamers, suitable for passing over the ship incline at the first cataract, there would be a saving of one day effected as compared with the Red Sea route, whilst the inconveniences and dangers of that passage would be avoided. Looking further to the future, when the line

is extended from the existing Egyptian railway system to the terminus at Wady Halfa, three days would be saved in the journey to India. We may thus consider it probable that before the lapse of many years there will be constructed a great through narrow gauge railway route across Egypt, competing directly and successfully with the Suez Canal, and carrying besides the whole of the local export and import traffic. That Mr. Fowler should, after long consideration, have adopted a gauge of 3 ft. 6 in. for a line of so great immediate and future importance, is, we consider, a striking answer to the many arguments and objections urged against narrow gauge railways so persistently during the past few years, and it affords us satisfaction that so eminent an engineer should have adopted principles we have so strenuously advocated.—Abridged from *Engineering.*

THE GAS SUPPLY OF THE METROPOLIS.

Dr. Letheby, the chief gas examiner appointed by the Board of Trade, has recently reported to the Corporation and the Metropolitan Board of Works the results of the testings of the Gas supplied by the Chartered, the Imperial, and the South Metropolitan Gas Companies during the months of October, November, and December last. From this it appears that the average illuminating power of the Chartered gas has been 17·34 candles at Beckton, 16·9 candles at Cannon Street, and 17·08 candles at Friendly Place, Mile End; that of the Imperial company has been 17·10 candles at Carlyle Square, 16·22 candles at Camden Street, and 15·9 candles at Graham Road; while that of the South Metropolitan Company has been 16·34 candles. The cannel gas of the Chartered Company has averaged 21·37 candles at Millbank, and 21·48 candles at Ladbroke Grove. As regards purity, Dr. Letheby reports that except on two occasions at Ladbroke Grove the gas at all the testing places has been constantly free from sulphureted hydrogen; and that although the amount of sulphur in other forms than this has fluctuated to a rather large extent, yet it has rarely been above the prescribed quantity. In the common gas at Beckton it has averaged 12·73 grains per 100 cubic ft., at Cannon Street 13·41 grains, at Friendly Place 13·02 grains, at Carlyle Square 19·55 grains, at Graham Road 22·94 grains, at Camden Street 20·33 grains, and at Hill Street, Peckham, 22·55 grains. In the cannel gas it was 21·4 grains at Millbank, and 20·4 at Ladbroke Grove. On seven occasions it exceeded the prescribed quantity—viz. once at Bow, once at Carlyle Square, and five times at Graham Road. On six of these occasions the Imperial Company appealed to the chief gas examiner, in accordance with the provisions of the Act of Parliament, and on inquiry it was ascertained that the excess was due to unavoidable causes arising out of the large demand for gas during the foggy weather of December last. Ammonia has not been present in undue proportions at any of the

testing places, but one—namely, that at Ladbroke Grove, where the amount for a considerable number of nights was excessive, thereby rendering the Chartered Company liable, under the 74th Section of the Metropolis Gas Act, 1868, to a penalty of 50*l.* for each night of such default.—*Times.*

A NEW GAS APPARATUS.

MM. MULLER AND EICHELBRENNER, of Paris, are the inventors of apparatus for producing illuminating Gas from Coal, &c. Already fifteen gas works in France have adopted it, and it has generally met with much approval. The inventors require no change in the ordinary arrangement of the works, but they do away with the old furnace and replace it by one of considerably smaller dimensions, placed at the back of the bridge, and surmounted by a receptacle of a slightly conical form. This can be filled with coke by its lower door, which is ordinarily kept closed, and its capacity is such that it does not require charging more than once in eight or ten hours. This plan is exceedingly advantageous for small gas works, preventing as it does the necessity of firing during the night.

This furnace is literally a gas producer, the fuel being kept in such a state of combustion, by regulating the admission of the air, that, practically, distillation of the volatile products is carried on. When leaving the furnace, the carbonic oxide and other combustible gases that have been generated enter into a cylinder at the back of the bridge, whence they pass into the oven by a series of openings, distributed over the entire length of the bottom. By means of other openings air can be admitted, which has already been heated during its passage from the external atmosphere, into the apparatus. The amount of air, and consequently of the combustion of the gases, that must ensue, is regulated by a register placed on the exterior of the oven. By means of refractory earthenware plates that can be forced against each of the openings to stop the passage of the gas, the rate of the combustion can be more completely regulated, and the temperature of all parts of the oven equalised. This heating of the air, effected by a method already familiar in the heat-economising furnaces of Siemens, Ponsard, and others, is less complete than theirs, but less expensive in its first construction. According to a report by M. Launy, the ease of working the furnace is great, the expenses generally are much reduced, and the removal of cinders and ash is not required. The principles applied are not new, but MM. Muller and Eichelbrenner have the merit of having combined and applied a variety of conditions of simplicity, efficiency, and economy that had not previously been realised. M. Launy visited the gas works of Montreuil, where one of these new furnaces had been erected alongside one of the old system, and expressed himself surprised at the results just mentioned, and generally gratified with its success.—*Engineering.*

THE AUGUSBURG WEB PRESS.

At least three types of web printing machines were exhibited at Vienna—the Walter, the Victory, and the Marinoni. The Victory machine is a folding as well as a printing machine, and is exhibited by the Limited Company in Liverpool, who are its sole manufacturers. A Marinoni press was exhibited by the Paris firm; and Sigl also has an "improved" Marinoni, with folding apparatus added, at work in the pavilion of the *Neue Freie Presse.*

This machine is intended to deliver up to a speed of 12,000 sheets, printed on both sides, per hour. The sheets are 525mm. by 770mm. (20·67 in. by 30·31 in.), and the type forme 485mm. by 725mm. (19·09 in. by 28·54 in.). The action of the machine is very simple. The roll of web paper is placed at the end of the machine as in the Walter press, but the paper is here taken from the underside of the roller instead of the top. This enables the whole printing part of the machine to be kept lower down, a somewhat different position having to be given to the distributing apparatus for the lower cylinder. The paper first passes through damping rollers, which can be arranged to give it any required degrees of wetness; and then it makes its way —through rollers which are adjustable to regulate its tension —to the first type cylinder. The two type cylinders and the two impression cylinders lie in the same vertical plane. The lowest and highest cylinders are the type cylinders, and the two middle ones the impression cylinders.

The paper is printed from the stereotypes cast in semicircular moulds so as to fit round the type cylinders. This method is adopted in all web printing machines, and by using it the founts of type may last twenty years instead of two, while the actual printing is quite as clear and good as if it were done from the type direct. The paper first passes between the lowest pair of cylinders, and is there printed on the first side. It is carried upwards and backwards by the revolution of the lower impression cylinder, and passed from it forwards again over the upper impression cylinder, and in passing between the latter and the upper type cylinder it is printed on the second side. As these four cylinders are all exactly of the same diameter, and are placed close together, the printing on the second side must coincide exactly in its position on the sheet of paper with that on the first. The printing operation being now completed, the paper passes horizontally forwards to the cutting cylinders. These are placed at the same level as the upper type and impression cylinders, and are necessarily of the same diameter, that diameter being such that their circumference is exactly equal to the length of the sheet which is to form one copy of the newspaper. On one of the rollers is an ingeniously arranged cutter, and on the other, at a corresponding point, a kind of groove or

seat for the projecting knife. As the paper on leaving the cutting cylinder is not led upwards at a steep angle as in the Walter press, it is not necessary to leave a small width on each side uncut, but the sheet is cut right across. The tapes, it will be seen, slope slightly upwards from the cutters in order to give sufficient height for the delivery apparatus. By an ingenious adjustment of their speed, the rate of each sheet is accelerated as it rises, so that by the time it reaches the delivery roller there is a distance of several inches between it and the one next behind it. The delivery takes place downwards, and alternately to right and left on to the tables, and the space between the sheets is necessary in order to allow time for the oscillation of the delivery frame. The apparatus for distributing the ink is very complete; that for the lower type cylinder is behind and below it, and that for the upper type cylinder behind and above it. Just outside the frame which carries the cutting cylinders is provided an index which marks the number of copies printed as they are cut off. There are many interesting and ingenious details about the machine, but they are unfortunately of a nature which cannot well be made intelligible without the aid of detail drawings.

The Walter press, it may be remembered, derives its name from Mr. Walter, M.P., the proprietor of the *Times*, to whose enterprise it was owing that the costly experiments were made which resulted in the production of the first successful web press. We believe the credit of its actual invention and construction is, however, due to Mr. T. C. Macdonald and Mr. Calverley, the manager and engineer respectively of the *Times* Printing Office. During the years 1863–66 the first machine was slowly elaborated, its construction being kept secret. For a year and a half more it took part in the printing of the *Times*, but still in secret, and still receiving such improvements and modifications as experience suggested, and it was not until 1868 that Mr. Walter considered the results so satisfactory that three more machines were put in hand. These were at work by the end of 1869, and since that the *Times* has been entirely printed from web paper, with a saving in working cost so great that it is asserted on the best authority that the capital sunk in the displaced machinery was recouped in less than two years. Last year the *Scotsman* commenced printing from the Walter press, and more recently the Vienna newspaper, *Die Presse*, and other papers, have also adopted it. The general catalogue of the Vienna Exhibition, as well as several of the special catalogues, have been printed on the Walter press in the office of the last-named newspaper, and are noticeable as being, we believe, the first *books* printed from continuous paper.—*Engineering*.

LITHOGRAPHIC COLOUR-PRINTING PRESS.

THE German Department of the Vienna Machinery Hall was particularly rich in printing machines of different kinds, both in number and in quality, the exhibits here being above those of other nations as represented at Vienna. Among them was the Lithographic Colour-Printing Press which was made at the Berlin establishment of the well-known Austrian engineer, Herr G. Sigl.

This machine is intended to print from stones up to 22 in. by 30 in., and, for common work, can turn off 900 to 1,000 copies per hour. If the work is, however, to be thoroughly well done, not more than 500 copies per hour can be worked. The ink-distributing apparatus is more complete than usual, the machine being intended for fine work. The ink knife is in two pieces, adjustable by the screws on the back of the box. The stone itself is fixed in a frame before being placed on the platten, and thus, in adjusting it, the frame only has to be moved, without touching the stone. The stone receives the colour from four sets of rollers, which themselves receive it from the slab while the impression is being made. The impression cylinder is fitted with a double set of knives, one set gripping the paper in position in the place in which it is put by the attendant, while the other set—lying underneath—as soon as the sheet is printed, and the first set release their hold, rise up, by means of suitable gearing, and guide the edge of the sheet neatly into the delivery rollers. In order to diminish, as far as possible, the number of tapes, which always have a tendency to dirty the paper, two wooden delivery rollers are employed, and through these the printed sheet is thrown on to the delivery table by a frame in the usual way. The usual rollers and water table for damping the stone are provided at the back of the impression cylinder.

The impression cylinder is driven only from one side. The means by which the cylinder stands still during the return motion of the platten—making an interval in which the feeder has time to adjust carefully the next sheet in its place—is that used in most of the machines. The wheel on the end of the cylinder has its teeth planed off in one place, so that the rack can pass clear underneath them without moving the cylinder, which, however, is also (to prevent accidents) held in position when the platten commences its motion by a lever pressing against a projecting pin. Just as the platten reaches the end of its return travel, and is about to start forward again with fresh colour on the stone to print another impression, it is arranged that this lever gives the pin a slight forward motion, so as to turn the cylinder round sufficiently to bring its teeth into gear with the rack, which then drives it forward in the usual way, the lever returning to its former position to be ready to catch the cylinder again as soon as the platten arrives at the

end of its travel. Spiral springs, put around the lower ends of the bolts which hold in place the axle of the impression cylinder, are used to prevent any excessive or undue pressure coming upon the stone. The stone itself, with the table on which it lies, can be raised or lowered by four screws, one near each corner, which in their turn are moved (through worms and worm wheels) by a couple of hand wheels. The platten itself, carried on a six-wheeled frame, is moved by the ordinary "railway" motion. The machine is provided with a hand lever, by which, at the same moment, the strap can be thrown off and a brake applied, so as to stop the machine instantaneously. The object of this is that a sheet, on which, perhaps thirteen colours out of fourteen have been printed, may not be lost altogether if the attendant notices in time that he has placed it wrongly on the cylinder. Gear is provided by which, when desired, the stone can be made to move either two or three times under the colour rollers for each sheet printed, and also gear by which the cylinder can be kept entirely stationary, and the platten moved backwards and forwards as many times as may be wished, in order to effect a thorough mixing of the colour.

The frame is neatly and strongly made, and the different parts of the machine are so arranged that, notwithstanding some necessary complexity, without which the various motions could not be obtained, they can all be taken apart for examination or repair with great ease.—*Engineering*.

We take this opportunity of acknowledging the great service of the ably conducted journal *Engineering*, in the accompanying records of the successes of the Vienna Exhibition.

CARDS AND CARD-MAKING.

MR. D. BATEMAN has read to the British Association an interesting paper "On Cards and Card-making," in which he entered into the history of the subjects, describing the nature of the process and the results sought and obtained, so important in production of the staple manufacture of the district. The machine by which these "cards" are produced is probably one of the most ingenious mechanical inventions ever brought forward, and must be seen to be appreciated. No description can give any idea of the complex and life-like mechanism of its construction.

IMPROVED TURNING-TOOL.

AT a late meeting of the Institution of Mechanical Engineers, a paper was read by Mr. Clay on an improved Turning-tool for metals, which permitted the cutting to be effected at a higher speed. This tool has one or more holes drilled in it up to its cutting-point, and a jet of water, which both cools and lubricates, is delivered on the cutting edge.

THE SAND-JET.

THE Sand-jet, which consists of a jet of steam or air carrying a small stream of sand, is being applied in America to many useful purposes, and especially to engraving. If a stencil of very thin india-rubber be stuck upon any surface of stone, glass, metal or other material which is intended to be engraved, the sand will rapidly cut away the surface except where it is protected by the stencil, and a very perfect pattern in relief may thus be obtained. Metal blocks for printing from, like stereotypes, of great delicacy, have thus been produced. A stream of dry sand and emery falling through a tube will suffice, without the propelling steam.

We need not criticise the paper descriptive of Tilghman's process of "cutting, grinding, engraving, and ornamenting glass, stone, wood, iron, and other hard substances." The process has been frequently described, and is shown in operation at the International Exhibition at South Kensington, so that it is needless to enter at length upon it here. It is simply the action of a stream of sand propelled by a blast of steam or air against the material to be operated upon, portions of which have been, so to speak, "stopped out" by "stencil plates," by means of which a pattern is produced on the surface, or if the action be prolonged, actual perforation is effected. This invention excited great interest, and its application to a variety of purposes was suggested.

SPUN SILK.

MR. LISTER has given to the British Association an interesting account of the "Spun Silk" operations carried on at the Manningham Mills, the largest silk-mills in Europe, and where, under patents taken out by the firm, the treatment of waste silk and conversion of it into Spun Silk was receiving great attention.

ARRASTRAS.

DR. C. LE NEVE FOSTER, has given to the British Association the results of experiments carried on by him for three years at the works of the Pestarena gold-mines in Italy, where about 6,000 tons of ore were annually milled in improved "Arrastras." It appeared that these machines extracted 73·3, 78·5, and 82 per cent. of the total gold contained in the ore. "Arrastra," it appears, is an old Spanish term for these stone-grinding mills.

MOHAIR.

THE raising of Mohair wool from Angora goats is now more than an experiment, several shipments having been made from California with favourable results. Difficulties have been encountered owing to the ignorance of the habits of the animal

and the laws which regulate its care and breeding with a view to the cultivation in perfection of wool suitable for fine textile purposes, and of a quality which will remunerate the breeder. Asia Minor being the natural habitant of the Angora goat, hitherto the finest and most silky fleeces have been brought from that quarter; but successful attempts have been made at the Cape of Good Hope in the rearing, and it is believed, on good grounds, that some parts of California are better fitted for the production of a valuable Mohair wool than either Asia Minor or the Cape. Capital, experience, and management will effect the rest. The chief points, an attention to which will bring about success, are a suitable locality having reference to the nature of the animal, and a vigilant care exercised in the maintaining of a pure thoroughbred stock. This last is of more consequence with regard to the Angora goat than perhaps to most animals, if the silky nature of the fleece is the object (the whole value nearly lies there); and, whatever may be the appearance of the animals, or the inviting exterior of crosses, this is the first and all-important consideration. A vast industry for America is in its infancy. No fabrics have taken a firmer hold, both here and abroad, than Mohairs, with the prospect of an extension only limited by the high cost. And there are animals closely allied to the Angora goat whose fleece is almost as valuable, and in some instances more so, that could be successfully reared on the land sloping from the Andes to the Pacific, where every necessary variety of climate for the raising of this class of stock is to be found.—*New York Times.*

MACARONI MACHINE.

A SET of machinery for making Macaroni has been exhibited at Vienna, by Messrs. Criscuolo, Kay & Co., of 57 Gracechurch Street. This consists of a white marble edge-runner, 4 ft. 6 in. in diameter, and 9 in. broad, attached to, and revolving with, a vertical shaft placed in the centre of a pan made of hard wood, in which the meal or semolina flour, mixed with a small quantity of water, is ground to a proper consistency. When the ingredients have been incorporated the paste is transferred to a vertical cylinder, 13 in. in diameter, in which a close-fitting piston is made to descend, by means of a 6-in. screw, with a slow thread. At the bottom of the cylinder is a gun-metal die plate, about 1 in. thick, perforated with a number of holes of the size required, each having a central wire of smaller diameter than itself. An annular space is thus formed, through which the paste passes, and leaves the die in the shape of a tube. The central wires are connected on the upper side of the die in pairs, so that at the top the annular spaces are partially occupied by the wires, although the paste meets and unites in the tubular form a very short distance from the upper surface of the die plate. The pressure brought on the paste to force it through the dies is 40

tons to the square foot. As the Macaroni receives its form it is removed from the press, twisted into shape, and dried for the market. We may add that this manufacture is conducted by Neapolitan operatives, and it has been carried on in England for the last two years, the works being situated at Camden Town.

KAFIR BEER.

An interesting article on "The Beer of Kafirdom" will be found in a recent number of the *Food Journal*. It is written by Dr. H. J. Mann, whose acquaintance with South Africa gives value to anything he may write on the subject. The Kafir beer, called *Uchwala*, is carefully prepared from millet by a process of fermentation. It has the appearance of thin gruel, and contains but very little alcohol. The jars in basket-work, employed to contain the beverage, are beautifully wrought, and form conspicuous objects in the huts; indeed, "the removal of the beer-pots from a hut is very nearly tantamount to unfurnishing the house.'

HOUSE CONSTRUCTION.

Captain Douglas Galton, C.B., in a paper read by him at the Royal Institute of British Architects, "on the Sanitary Effect of House Construction," quoted the result of some experiments by Dr. Pettenkofer and others as to the absorption of water in new brickwork, and its effect on the internal atmosphere of a house. He advocated the use of hollow walls, not only as a precaution against damp from without, but as a means of retaining heat within, and insisted on the necessity of scraping and renewing from time to time the plaster lining of rooms, especially in hospitals, where the walls are liable to become charged with deleterious matter. Wood floors, unless laid with close joints, were described as likely to become receptacles for dirt washed into them by the very process of scrubbing, and plate glass was recommended for windows to insure warmth. The lecturer then described the general principles of ventilation, and mentioned the fact, which, he said, could not be too often repeated, that since the subject had received attention in the planning of barrack-rooms, &c., the death rate from chest diseases in the infantry had been reduced from 10·1 to 3·3 per 1,000 men. Regarding the open fireplace as in this country the main engine for the removal of air from rooms, Captain Galton showed how it might be adapted to a system of ventilation. He deprecated the use of close stoves, as in Germany, where economony in fuel was effected at a sacrifice of health; and, after referring to the old Roman plan of warming the floors, expressed his opinion that ventilation should be obtained at some aperture near the ceiling, so that cold air might pass in and sink down gradually to replace the warm air which would pass up from

the floor. He considered that an ordinary sunlight was not an effective ventilator when used in the same room with an open fireplace, inasmuch as they both drew off air, and the two currents interfered with each other; but he showed how a central globe might be substituted for the sunlight. Captain Galton concluded by admitting that he had advanced no new theories, but had rather urged the necessity of their practical application, for which he considered architects responsible.

MANUFACTURE OF HORSE-NAILS.

MR. BRAMWELL has described to the British Association the machinery invented and used by Messrs. Huggett for the manufacture of "Horse-nails." A horse-nail certainly looks as little adapted for production by machinery as anything that can be imagined, its peculiarily irregular and varied shape to the ordinary observer seeming to require special action directed by the will of the smith to fashion it. Messrs. Huggett, after a long series of trials and many disappointments, have at last produced machinery by which these nails are now turned out in large quantities, and of a quality which satisfactorily bears the test of the farrier's critical judgment and practical skill. Many and many were the failures before this result was obtained, but perseverance and Messrs. Hugggetts' mechanical knowledge and experience have enabled them to overcome all difficulties, and success rewards their endeavours, and another manufacture is added to the already lengthy list.—See also *Year-Book of Facts*, 1873,

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TRAINING SCHOOL OF COOKERY.

MORE than a century ago the art of making pastry was taught in "schools" in London with great success; and cookery, in its simplest and most economical forms, was taught with like good results. Then, these duties were inculcated by the "Lady Bountiful" of the day; and next, these teachings became an integral part of our International Exhibition, extended by our intercourse with the Continent, and an assimilation of foreign and English cookery, by which improved methods are taught with a success which shows how

> "That climax of all earthy ills,
> The inflammation of our weekly bills,"

may be kept down, at the same time that the quantity and quality of the family meals are increased and bettered by the mistress' personal superintendence of her cook and kitchen. The *bourgeoise* housewife is upbraided for the sham gentility which leads her to teach her daughters how to play the piano instead of how to boil a potato.

The progress in this School of Domestic Art during the past year has been rendered remarkable by the visit of Her Majesty

the Queen, accompanied by the Princess Christian and the Princess Beatrice, to the School at South Kensington.

The Hon. F. Leveson Gower, Chairman of the Committee of the School of Cookery, and the other members of the Committee, conducted the Queen and Princesses to chairs in the School. Mr. Buckmaster, the Lecturer of the School, then made the following observations, during which an *omelette aux fines herbes* was prepared:—

"May it please your Majesty,—The specimen of cooking which is now to be presented takes only four or five minutes, and is within the reach of the poorest of your Majesty's subjects. The materials cost 3½d., and they furnish a wholesome, nourishing dish, acceptable for two persons. The omelette is seldom properly cooked even in France, which gives it its name. We wish to show in this school not only the best and most economic methods of domestic cooking, but the various uses to which kitchen utensils may be fairly applied without injury. We use gas-stoves and duplicate all our operations, so that the public may have a better opportunity of seeing; but what we do at these gas-stoves we can equally well do at an ordinary kitchen fire-place. To make simple food wholesome and palatable by cooking was a duty imposed on man from the very earliest period of his civilization. An abundant supply of food and the proper preparation of it by cooking are matters intimately connected with the physical wellbeing and happiness of your Majesty's subjects; and, from a long and close connexion with the working classes, on their behalf I may be permitted to say that the interest which your Majesty has shown in this school of popular cookery will be gratefully appreciated by all classes of your Majesty's subjects."

This demonstration occupied just four minutes, and the Queen and the Princesses each tasted the omelette, which Her Majesty pronounced to be very good.

BUTTER AND ITS ADULTERATIONS.

At a meeting of the Society of Medical Officers of Health, held at the Scottish Corporation Hall, under the presidency of Dr. Hardwicke, a paper was read by Dr. C. Meymott Tidy upon "Butter and its Adulterations." Dr. Tidy said that butter was generally prepared from cream collected from time to time and allowed to get slightly sour. It was then churned, or, in other words, rapidly stirred. The best temperature for churning was from 50 to 55 degrees Fahrenheit, and hence most churns had an outside vessel either to warm or cool the apparatus as it appeared necessary. Churning should not be too slow, or the flavour of the butter would be entirely destroyed; nor too fast, or the butter would be soft and frothy. Butter was also made from fresh cream and from entire milk. This should stand until it was sour, and then be churned at a higher temperature than cream—namely, 60 degrees. More butter was

obtained from entire milk than from cream, but there was more work in the churning, and it took longer. Milk on an average yielded from 4·5 to 5·5 per cent. of butter, and it might be roughly stated that a cow yielded about one pound of butter daily. It was next taken out of the churn and washed with water, so as to get out the adherent whey. That operation was important, as the butter would otherwise decompose more rapidly. It was then salted, about 4 per cent. of salt being a fair quantity to be added. The amount of stearine, oline, and palmatine in the composition of butter was practically *nil*. The first adulteration of butter was water. Let them dry 100 grains of pure butter in a weighed capsule for several hours at 220 degrees Fahrenheit, and from 5 to 8 per cent. of water would be produced. Water was incorporated with the butter chiefly when it was in a semi-solid state, and also by beating out and sprinkling. Dr. Tidy was able thus to incorporate 28 per cent. of water with butter. Out of 130 samples of butter purchased at different shops in Kent, seven contained from 7 to 9 per cent. of water, 21 from 9 to 10 per cent., 34 from 10 to 13 per cent., 42 from 14 to 17 per cent., 17 from 18 to 24 per cent., and 9 over 25 per cent. Thus water might become a very serious adulteration of butter. It was his practice when analyzing butter, in his capacity as public analyist, to state in his certificate the amount of water if over 10 per cent., and to leave the magistrate to draw his own conclusion. The next adulteration was salt. To trace this they should incinerate the remainder of the 100 grains used for drying. In 12 specimens of undoubtedly pure butter the average amount of salt traceable was 5·2 per cent., and out of 27 samples of butter indiscriminately purchased he found that 2 contained less than 3 per cent. of salt, 2 between 3 and 4 per cent., 3 between 4 and 5 per cent., 4 between 5 and 6 per cent., 10 between 6 and 7 per cent., 2 between 7 and 8 per cent., one between 8 and 9 per cent., 2 10 per cent., and 1 17 per cent. Over 1 per cent. of salt he considered to be excessive. Adulteration was likewise produced by the incorporation with butter of dripping, lard, suet, and other fats. These could not be mixed with butter when they were in a melted state, but only when they were cold, and hence the mixture was never perfect. The fats, unlike real butter, contained stearine, palmatine, &c., in considerable amount. To trace the presence of these fats, let them note the melting and solidifying points. Butter melted upon an average at 75 degrees, and solidified at 63, dripping melted at 79·5, and solidified at 72·5, and suet melted at 82, and solidified at 75. Another test was the taste. The taste of real butter could be detected even when it had been most extensively mixed. Pure butter melted quickly on the tongue, and there was no sense of granulation; but when adulterated with other fats it melted far more slowly, and a peculiar granulated feeling in the mouth was produced as the last few grains disappeared. The odours of butter and of

dripping were easily distinguishable, but the smell of lard when mixed with butter was not so soon detected. Good butter was generally of a rich yellow colour, entirely uniform; but when adulterated the colour was very much paler, and it was marbled, owing to the imperfect admixture of other fats. He regarded streaky butter generally with suspicion. In good butter a uniform surface was produced by passing a clean knife rapidly over it, but impure butter had a granular appearance. Dr. Tidy concluded by describing other but more technical ways of detecting bad butter, such as the action of ether and the use of the microscope with polarized light. At the instance of Dr. Hardwicke, the Society passed a cordial vote of thanks to Dr. Tidy for his interesting remarks on so important a subject. A short discussion ensued, in which Dr. Stevenson, Dr. Bernays, and Dr. Tripe joined, and the general conclusions of the lecturer were confirmed. Dr. Bernays observed that from 5 to 6 per cent. of water undoubtedly improved butter, and the addition of more than 7 per cent. of salt would render it uneatable. When in a butter of 1*s*. per pound he found no less than 22½ per cent. of salt and water he could not think it cheap at the price. The meeting then terminated.

Very good butter, it is stated, is prepared now by a butter manufactory at New York, according to the following process:—Agents are employed to visit slaughter-houses, and buy up all the beef suet. This is carted to the factory and cleansed. Then it is put into meat choppers and minced fine. It is afterwards placed in a boiler with as much water in bulk as itself. A steam pipe is introduced among the particles of suet, and they are melted. The refuse of the membrane goes to the bottom of the water, the oily substance floats, and is removed. This consists of butter matter and stearine. A temperature of 80 degrees melts the former, and leaves the stearine at the bottom. The butter matter or cream is drawn off; about 13 per cent. of fresh milk is added and the necessary salt, and the whole is churned for 10 or 15 minutes. The result is Orange county butter at about one half the usual cost. The stearine is sold at 12c. a pound to the candle-maker, and the refuse at 7c. a pound to the manufacturer of food for cattle. A company with a capital of $500,000 has been organised for the manufacture of butter by this method, and it is expected that the dividends will amount to 100 per cent. In the meantime a chemist in France is reported to have made milk from grass, but as the milk thus made is much more costly than old-fashioned milk, his discovery is not likely to be so profitable as that of the butter manufacturer.

TEA AND ITS ADULTERATIONS.

Dr. Hassall has contributed to *Food, Water, and Air*, a paper on the Adulteration of Tea—a subject which

at the present time possesses more than ordinary interest. The paper is devoted to the examination of one particular kind of tea—namely, caper; this, though resembling outwardly a black tea, has more the properties of a green tea. There are two descriptions of it in the market—namely, Canton and Foochow caper, the latter being considered the best. It is usually scented, and is for the most part used for mixing with other teas. It is never, we believe, used by itself in England out of the northern portions of the Midland Counties, where it is occasionally taken unmixed. The great bulk of the caper imported is used in the manufacturing districts, and a little is used also in the West of England. The proportion employed in mixing varies from one-fourth to one-half, and in Lancashire even more in some instances. In London, caper is very little used. The samples, the results of the rigid analyses of which are given in the report, were obtained from brokers and merchants. Most of them came from different ships, and therefore they represent large bulks of tea, and the 20 samples tested were taken just as they came to hand, and without selection. Of the 20 teas analyzed one only was found to be genuine, and that was the Foochow caper; the other 19 samples were adulterated. All these were faced with plumbago or blacklead, contained lie-tea, iron filings, sand, and fragments of quartz in variable quantities. The term "lie-tea' has been very candidly given to the article by the Chinese themselves, for it consists not of tea leaves, but of tea dust or the dust of leaves not tea, sand, frequently iron filings, made up with gum or starch into little masses, faced with plumbago in imitation of caper, or with Prussian blue and turmeric in imitation of gunpowder teas. The quantities of iron filings met with in the 20 teas varied from 0·06 to 5·86 per cent. of the tea, the sand from 2·09 to 12·83, and the ash of the lie-tea from 13·05 to no less than 52·92 per cent. in place of about 5 per cent. present in genuine tea. The extractive matter of genuine green tea being about 40 per cent., that of the adulterated teas ranged from 26·69 to 37·94.

The theine, which is one of the principal constituents of tea, present in green tea in the proportion of about 3 per cent., was in nearly all cases deficient, and in one instance as low as 0·82 per cent. It is thus seen that the practice of adulterating this description of tea in a very scandalous manner is very common. No doubt many of the samples were of inferior quality, yet the prices at which the different samples were offered for sale varied as much as 300 to 400 per cent., without however any corresponding differences of quality being as a rule observable. From the small quantities of iron filings met with in some of the teas it is obvious that they are added in many cases not for the sake of bulk or weight, but for a purpose to be mentioned hereafter, although in some instances the amount was so considerable as to add materially to the weight of the tea. The

sand and particles of stone, consisting mostly of quartz, were doubtless added solely for the purpose of increasing the weight. One of the samples of tea examined contained nearly 6 per cent. of iron filings. Now, since tea contains naturally a large quantity of tannin, there are thus brought together the two chief constituents which enter into the composition of ink, and by appropriate treatment a bottle of ink was made from the tea in question, and of which the article we are now noticing was in part written. What has thus been accomplished in the laboratory it is not impossible may arise in the human stomach into which largely adulterated iron filing tea has been received. The object of the Chinese in adding iron filings to tea is now therefore apparent. The iron, slowly dissolved by the acid of the tea, forms tannate of iron, and the colour of the infusion made with such tea becomes thereby darkened. It is, then, to prepare a tea which will furnish a dark solution, so greatly preferred by many people, that the Chinese have been led to make the addition in question.

CONSUMPTION OF TEA IN THE UNITED KINGDOM.

THE steady increase in consumption which this article of food exhibits year after year is a subject for congratulation to all concerned in the trade. In 1871 the consumption of tea in the United Kingdom amounted to 123,500,000lb.; in 1872 it increased to 127,750,000lb.; and in 1873 it had reached 132,000,000lb. The quantity exported from the United Kingdom, on the other hand, again shows a marked falling off. In 1871 it was 41,000,000lb.; in 1872, 38,500,000lb.; and in 1873, 32,500,000lb. This falling off is due entirely to the preference shown by Continental buyers for direct shipments from China, instead of supplying themselves, as formerly, from this market, and is in point of fact a real gain to the home-trade buyers, inasmuch as it does away with the competition which used to occur between the two branches of the trade.

Indian teas continue in strong favour, and prices are gradually tending upwards, stimulated by improvement in quality. The imports into the United Kingdom have been 164,000,000lb., against 182,250,000lb. in 1872; the deliveries for home consumption 131,500,000lb., as against 127,500,000lb. in 1872; the deliveries for exportation 34,000,000lb., against 39,500,000lb. in 1872; the stock remaining on the 31st of December was 97,000,000lb., against 98,500,000lb. in 1872.

THE ADULTERATION OF FOOD ACT.

DR. WHITMORE, analyst of Marylebone, has presented a report to the local authorities, in which he states that the articles of food and drink sold in the parish, which he had analyzed, comprised nine samples of bread, seven of flour, one of

brandy, four of milk, two of black tea, six of ground coffee, one of pickled onions, one of port wine, and five of mustard—in all, 60 samples. With regard to bread, two samples appeared to be genuine, five contained alum in very small quantities, and two in considerable quantities; and in these last two cases the vendors were prosecuted and fined. Of the seven samples of flour, two only contained traces of alumina. The brandy was genuine and excellent in quality; it was sent by a gentleman who said he "always felt ill after drinking it." Of the three samples of milk, two were genuine and one adulterated with about 28 per cent. of water; and in this case the vendor was prosecuted and fined. The two samples of cocoa were sold as prepared, and not as genuine cocoa; both contained cane sugar and starch in considerable quantities. All the samples of black and white pepper appeared to be genuine; some were more coarsely ground than others and appeared to contain a larger quantity of husks, but no foreign substance could be detected. The 12 samples of tea varied very considerably both in quality and appearance; in some, which were purchased for 1s. and 1s. 2d. per lb., they appeared to be mixtures of broken leaves, stalks, and dust; the infusions of these samples were by no means agreeable either to the taste or smell, but yet they appeared to be free from adulteration. One sample, which to appearance was good tea and free from stalks and other tea refuse, was found to contain at least 17 per cent. of iron filings, together with some small portion of sand, and in this case a summons had been taken out against the vendor. Of the six samples of coffee, four were sold as genuine coffee and were found to be so; the other two samples were labelled as mixtures of coffee and chicory, and Dr. Whitmore is of opinion that the permission to sell a mixture of coffee and chicory should be qualified by requiring the vendor to state the exact proportion of the chicory added to the coffee. In the samples examined the chicory was very largely in excess, but the price charged was not very much less than that paid for genuine coffee, although chicory may be bought for one-third the price. The pickled onions were labelled as having been "prepared with the very best malt vinegar;" but the vinegar was very largely diluted, and a very considerable quantity of common salt had been added. The port wine was evidently a made-up wine. It was very acid, but it did not contain either logwood or alum. Of the five samples of mustard, one only approximated to genuine; the other four were adulterated with wheaten flour and turmeric. As these samples were sold without any qualification, but simply as "mustard," it is intended to take out summonses against the vendors of them. Since the Adulteration of Food Act has been in force the quality of many articles of food and drink sold in the parish has become improved, especially the milk and bread.

General Science.

THE NEW PRESIDENT OF THE ROYAL SOCIETY.

Dr. Joseph Dalton Hooker, of Kew Gardens, the eminent botanist, who has been elected the successor of Sir George B. Airy in the presidential chair of the Royal Society, is the son of the late eminent botanist, Sir William J. Hooker, of Glasgow, and subsequently director of the Royal Botanical Gardens at Kew. He was born in the year 1817, and was educated for the medical profession. More than 30 years ago he sailed with the late Captain, afterwards Sir James, Ross, to the Antarctic Pole, as assistant-surgeon, on board Her Majesty's ship *Erebus*, and on his return to England published his *Flora Antarctica*, which at once placed him in the foremost rank of botanists. His next expedition was to the Himalayas, the Flora and Fauna of which he described popularly in his *Himalayan Journal*, and more scientifically in other quarters. Dr. Hooker had already acted for some years as botanist to the Geological Survey of Great Britain, under the late Sir Henry de la Beche, under whose auspieces he contributed to the *Transactions* of that institution some important papers upon the vegetation of the carboniferous period, as compared with that of the present day, and upon the general structure and appearance of our fossil coal system. About 18 years ago he was appointed assistant director of the Botanical Gardens of Kew, and succeeded to the directorship at the death of his father in 1865. Dr. Hooker is an honorary D.C.L. of Oxford, and LL.D. of Cambridge, and a Fellow of the Linnæan and a variety of other learned and scientific societies at home and abroad. It is now many years since the "throne of science," as it has been called, has been occupied by a botanist, Sir Joseph Banks having been the last, if we may accept the statement of a writer in the *Gardeners' Chronicle*, which expresses "the satisfaction which all engaged in the pursuit of plant lore must feel at the selection of Dr. Hooker for the chief post of honour in the scientific world."

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The second Meeting of the French Association for the Advancement of Science was held at Lyons from the 21st to the 28th of August, under the Presidency of Prof. Quatrefages. This Association bids fair to become as popular in France as the British Association in this country. The work done in the sections of Anthropology and Geology was, to say the very

least, as valuable as that done by our own sections. Among the papers brought before the former, the pleistocene station of Solutré excited considerable interest, and was subsequently visited by the section. The site has been used by man for habitation and burial as late as the Merovingian times, in which it was a cemetery, and the strata are to a considerable extent *remanié*. The association of remains on that spot of varying age, Palæolithic, Neolithic, and Frankish, seems to throw a doubt on the precise date of the human skeletons, buried at full length, and generally believed to be of the same age as the associated implements of reindeer and bones of mammoth. Dr. Gosse also read a paper on the reindeer-cave of Veyriers, Switzerland, and exhibited carved implements of reindeer antler, usually called "batons de commandement," which are of the same form as the arrow-straighteners of the Eskimos. Here, as in the caves of Belgium explored by M. Dupont, they presented but one perforation. The debates were very animated, and drew out many valuable remarks from the eminent anthropologist, Dr. Paul Broca.

In the Geological section, papers were contributed by the Comte de Saporta, MM. Dumortier, Beboux, and others, and in the debates Prof. Carl Vogt of Genova took a prominent part. MM. Falsan and Chantre exhibited and described an elaborate map of the glacial phenomena of the middle basin of the Rhone, drawn on a large scale. They traced the glaciers of the Alps, and of the Jura, as far to the west as the Saône, and as far to the south as Valence; and they proved that there were two epochs of glaciation, the one during which the area in question was covered by a great ice-sheet, conveying Alpine blocks over the Jura into the valley of the Saône and middle basin of the Rhone, and the other during which the glaciers were isolated, and local moraines accumulated in the river valleys. These two periods correspond with those which have been noted in Great Britain and Ireland, by Prof. Ramsay, Hull, and others. The map presented a combination of artistic skill, with careful work in the field, which is very rarely met with.

In the evening three popular lectures were given to the public, one of which, by M. Janssen, on the Constitution of the Sun, was admirably illustrated.

The sections were 15 in number, and comprised Agriculture and Medicine, as well as those represented in the British Association.—*Nature.*

MATHEMATICAL BIBLIOGRAPHY.

Among the papers on pure mathematics read to the British Association, the most interesting were Mr. J. W. L. Glaisher's contributions to Mathematical Bibliography. The canon of sines, tangents, &c., was in 1575 in the same state as it is now, having been for a long time in use on the Continent; but up to this date

it had not been used at all in England. The invention of logarithms made an enormous change; and England, from being far behind, rushed far ahead. There has been much controversy as to who first used the decimal point. Peacock, on erroneous grounds, claims the honour for Napier. De Morgan, on the same evidence, denies the claim; but Mr. Glaisher has found in Napier's latest work, the 'Constructio,' which is so rare that neither of these authors had seen it, more than two hundred instances of the use of the decimal point precisely as it is used now, together with a definition of its meaning precisely such as would be given now. Decimals were invented by Stevinus, but his notation was excessively cumbrous; and more or less cumbrous modes of notation were employed, each decimal figure having some mark above or before it to indicate its value, until Napier introduced the improvement of making one point serve for all. —*Athenæum.*

ON AIR AND GAS.

Professor Odling, in his Christmas lectures at the Royal Institution, commenced with familiar illustrations of the buoyancy of water, stating that, as by the suspension of a heavy body in a vessel of water, an addition is made to the pressure of weight supported by the vessel, so a corresponding subtraction is made from the strain on the point of suspension, a portion of the weight being supported by the upward pressure of the water. The buoyancy thus imparted to the suspended body is a result of the weight of water, and of its property of transmitting pressure in all directions. The amount of upward pressure exerted by water on a submerged body being equal to the weight of a quantity of water of the same size as the body, it follows that bodies of the same density as water, by their buoyancy when submerged, cease to manifest any weight. In raising a bucket of water from a well its weight is not felt so long as it remains in the water. After further experimental proofs, the Professor proceeded to consider the properties of air, which he demonstrated in various ways to be a material substance, not only when in motion as wind, but also as capable of being felt when at rest, enclosed in a bladder, and transmitting pressure in every direction. He then showed how air can be weighed in several ways. By means of the air-pump, the air contained in a flask was sucked out completely and weighed. It was then refilled with air and again weighed, the increase of weight being noted. Air was thus shown to be comparatively a heavy body. Under standard conditions, a cubic foot weighs exactly 537 grains, or nearly an ounce and a quarter; and the Professor stated that the theatre of the Institution contains above 30,000 cubic feet of air, weighing upwards of a ton. He then adverted to the existence of other kinds of air, or gas—exhibiting the inflammable gas obtained by the action of dilute

sulphuric acid from metals, termed hydrogen, the lightest of all gases—ordinary air being fourteen and a half times heavier; and he showed that a heavy balloon filled with hydrogen ascended in the heavier air in the same way that heavy logs of timber rise in the heavier water. The properties of marsh-gas and coal-gas were also considered and illustrated.

Professor Odling began his second lecture with several instructive illustrations of the effects of the buoyant action of water and air, including an experiment by which he proved that when two bodies of different sizes balance each other, in either water or air, the larger must be really the heavier, its greater weight being compensated by the greater amount of buoyancy of water or air. He then proceeded to consider and exhibit the property possessed by air of expanding, so as to fill up an enlarged space, of which property advantage is taken in the construction of the air-pump. As the air in the glass bell, termed the receiver, is gradually withdrawn by pumping, the remaining air swells out and occupies the space afforded in every direction; but an absolutely perfect vacuum is unattainable, since some air in an exceedingly attenuated state is always left behind. Of this the Professor gave brilliant proofs, by exhibiting several of Mr. Gassiot's vacuum tubes, in which a mere trace of the particular kind of gas left behind was recognised by the peculiar colour of the electric discharge passed through it. Professor Odling, after considering the principle of the ordinary air-pump, consisting of a receiver connected with a cylinder and piston or plunger, explained the construction of the valuable air-pump of Dr. Sprengel, in which the piston is replaced by a succession of drops of mercury, each of which acts as a piston by falling through a long tube and sweeping out the air. Having thus shown that the air-pump depends for its action on the property of air to spread itself out into any enlarged space given to it, the Professor explained and illustrated the principle of the condensing syringe, which depends for its action on the property of air to suffer compression into an exceedingly diminished space. These correlative properties of air, he said, are not known to have any limits. Air has been compressed into one six-hundredth of its original bulk, and may be expanded many thousandfold, and thus differs altogether from water. Among other examples of the force of compressed air the air-fountain was exhibited, a jet of water being thus projected many feet upward. The tendency of ordinary air to expand was also shown by the expansion of the air in a bladder in the exhausted receiver of an air-pump, and in other ways, this expansion in ordinary cases being opposed by the external pressure of the atmosphere. This state of air the Professor compared to the force of a spring-coil pressed upon by a weight. For the spring to remain in a particular state there must be an exact balance between the elasticity of the spring tending to raise the weight and the

pressure of the weight tending to compress the spring. In some cases, when the atmospheric pressure is removed, the expansive force of the air is sufficient to break the vessel containing it.

EXPLOSION OF WATER.

PROF. S. PIAZZI SMYTH, the Astronomer-Royal of Scotland, has communicated a paper to the Manchester Literary and Philosophical Society, the point of which was to show "that water is a far more powerful exploder than gunpowder if you can get it (the water) to explode at all." After showing that great heat will, under certain conditions, cause water to explode, he leaves the further development of the subject in the hands of men of science.

DYNAMICS.

THE Franklin Institute of Philadelphia, considering the want of certainty and accuracy existing in the science of dynamics, have appointed a committee "for the purpose of establishing precision to the meaning of dynamical terms, and to select and approve such terms as may be found proper, and reject those which they consider unnecessary."

INDUCTION AND DEDUCTION.

IN the Report published of the Board of Regents of the Smithsonian Institution at Washington, there is a paper on Induction and Deduction, by Baron Liebig, in which it is stated that great discoveries are made, not so much by force of logic as by the action of the imagination, which, in reality, is the great discovering power. What is thus generally conceived subsequent research either verifies or disproves. But in science, as in ordinary affairs, the subject is first grasped by an act of the imagination.

WAVE MOTION.

IN *Nature*, vol. viii. p. 506, Mr. Woodward has suggested a simple and ingenious illustration of Wave Motion.

In the case of sound-waves the propagation is comparatively simple, and is fully and clearly explained in Dr. Tyndall's *Lectures on Sound.* Helmholtz, in his *Popular Lectures*, has figured the motion of the individual particles of which a water-wave is composed. And in Sir John Herschel's *Familiar Lectures* there is an elaborate and beautiful demonstration of the motion of the particles of ether in plane and circularly polarised light; but neither of these expositions appears to deal with the mode of propagation of the motion by which the wave is formed.

On the other hand, Sir Charles Wheatstone's ingenious model

beautifully exemplifies the interaction of *waves* and their results. But here the waves are produced by the wooden wave forms introduced into the machine, the beads representing the particles remaining fixed in relation to each other. Neither, therefore, can this explain the manner and direction of the actual impact of each particle upon the adjacent one (beginning with those in contact with the source of motion itself), to which, combined with the tendency to yield in the direction of least resistance, the water-wave must owe its form, and upon which the still more complicated conception of the light-wave must ultimately depend.

THEORIES AND ILLUSTRATIONS OF COMBUSTION.

Dr. Debus, F.R.S., began his second lecture on Oxidation, at the Royal Institution, by remarks and illustrations of the different capacities for heat possessed by different substances—that is, the different amounts of heat they need to raise them to the same temperature. He then referred to the old notions that the heat and light generated by two combining substances was their surplus heat, and that the resulting compound had less capacity for heat than its constituents. Now, however, heat is considered to be a mode of motion. Before Lavoisier, sulphur, phosphorus, carbon, and the metals, were believed to be bodies combined with heat. Thus iron was held to be iron rust and heat. Oxygen, moreover, was held to be a constituent of all acids, because substances burnt in this gas form compounds which redden a solution of litmus, the test for acids—this being the case with sulphur, phosphorus, and carbon. Davy, however, demonstrated the existence of true acids (such as hydrochloric acid) which contain no oxygen; and he also proved that some substances burnt in oxygen produce not acids but powerful alkalies; for instance, potassium, sodium, and others, the metals of the alkaline earths. Combustion, Dr. Debus stated, is a term relative to the atmosphere in which it takes place; that oxygen, which is incombustible in air, burns readily in hydrogen (as was discovered by Cavendish), in coal-gas, and in other vapours, was well shown in a series of experiments. The ignition of finely-divided iron on exposure to air was exhibited as an example of the intense action set up between the molecules of bodies brought into close contact; and Döbereiner's discovery that finely-divided platinum has the power of producing contact between gaseous bodies was also shown. A little of this powder placed upon blotting-paper and held over a jet of unlit hydrogen became red hot, burnt the paper, and inflamed the gas. That compounds containing oxygen can be made to transfer it with the production of heat and light was proved in the case of iron filings thrown into chlorate of potash, and a red-hot piece of charcoal placed in strong nitric acid continued to burn till it was consumed.

OZONE RESEARCHES.

In the *Berichte der Deutschen Chemischen Gesellschaft zu Berlin* a paper by Prof. Schöne has appeared, "On the Reciprocal Behaviour of Ozone and Water." The chief points of interest resulting from this investigation are, that Ozone does not convert water into peroxide of hydrogen; that a considerable quantity of ozone is absorbed by water, even at ordinary temperatures, but that it suffers no qualitative change; that there is a loss of ozone when it is passed through water, beyond that which is absorbed, which is due, it is thought, to the conversion of ozone, by the action of water, into common oxygen. In the *Journal* of the Scottish Meteorological Society, Dr. T. Moffat, of Hawarden, has a curious paper "On Atmospheric Ozone and its Sources." He thinks that he has proved, by observation and experiments, that there is an intimate connexion between phosphorescence and ozone. He states that the brilliancy of phosphorescent bodies varies with the state of the weather; that the glow-worm is more luminous in unsettled than in settled weather; that the luminosity of the sea, produced mainly by the night-shining Neries, is a precursor of storms, and that then ozone is produced. The atmospheric conditions of periods of phosphorescence are the same as those of ozone, and periods of non-phosphorescence and no-ozone periods occur under similar conditions.

The *Athenæum* conceives that Dr. Moffat has entirely neglected the ever-varying electrical conditions which are known to be intimately connected with the development of ozone.

In Italy it has been found that essential oils—such as those of peppermint, lavender, nutmeg, thyme, and others—develop large quantities of ozone when exposed to sunlight in contact with the atmosphere.

MAGNETIC STORM.

A connection between the appearance of Sun Spots and the disturbance of the Magnetic Equilibrium has long been known to exist; and, in a late communication to *Les Mondes*, the Astronomer-Royal states that a Magnetic Storm manifested itself on July 7, on which day Father Secchi observed a remarkable explosion on the limb of the sun. By a comparison of the times it is reckoned that, if a connection really exists between the solar explosion and the magnetic storm, it would have taken about two hours and twenty minutes to transmit the influence from the sun to the earth; and the relation, if verified, would constitute an important cosmic fact that might afford a key to other inquiries.—*Nature.*

TERRESTRIAL MAGNETISM.

Prof. Challis has communicated to the *Philosophical Magazine* for January a paper, "On a Theory of the Source of

Terrestrial Magnetism." This places in a clear light the Professor's hydrodynamical theory of magnetism, and explains his view of the modes of generation of those steady streams of the ether, by the agency of which the principal facts of the proper magnetism of the earth may admit of explanation.

THE SAFETY LAMP OF SIR HUMPHRY DAVY.

MR. WILLIAM SPOTTISWOODE, in his very interesting paper "On the Old and New Laboratories at the Royal Institution," observes: "The disappointment of the last seventeen years of the life of Davy is illuminated by the invention, not less original in its conception than benevolent in its object, of the Safety Lamp. Mr. Spottiswoode observes:

"The great value of this contrivance, and of questions arising out it, will, I trust, be sufficient apology for diverging again from my story in order to mention some very important experiments now in progress by Mr. Galloway. Explosions, it is well known, occur even in cases where the Safety Lamp is used. And it has been noticed that in these cases they occur most frequently after the firing of a blasting shot in the neighbourhood; and as it was almost certain that the penetration of the flame through the gauze of the lamp was not due to a sudden flow of gas from one part of the mine to another, experiments have been instituted to determine whether the transmission of the sound wave, or wave of compression, may not have been the means of producing the mischief. Through the kindness of Mr. Galloway we have here a tube arranged for making such an experiment. At one end there is the inflammable current enveloping a safety lamp; in the centre is a loose diaphragm, and at the other end a pistol will be fired, by the explosion of which a sound wave will be propagated along the tube. On the arrival of the sound wave at the extremity of the tube, the combustion will pass from the inside to the outside of the Safety Lamp. But I here leave the matter in the hands of Mr. Galloway, of whose experiments we hope to hear more hereafter."

Mr. Spottiswoode gracefully refers thus to the Fullerian Bequest, as "the one act of wisdom among the many aberrations of an eccentric member of Parliament, which saved Faraday to us, and thereby, as seems probable, our Institution to the country. The liberality of a Hebrew toy-dealer[1] in the East of London has made the rebuilding of our laboratories possible.

"It is said that Mr. Fuller, the feebleness of whose consti-

[1] Mr. Alfred Davis, after paying his composition of sixty guineas, as a Member of the Institution, and three annual donations of twenty guineas for the promotion of research, at his death in 1870 bequeathed 2,000*l*. for the same purpose. His deafness prevented him from deriving any benefit from the Lectures.

tution denied him at all other times and places the rest necessary for health, could always find repose and even quiet slumber amid the murmuring lectures of the Royal Institution; and that, in gratitude for the peaceful hours thus snatched from an otherwise restless life, he bequeathed to us his magnificent legacy of 10,000*l*. If this evening's discourse shall have ensured one such blissful hour to any of his audience, your lecturer's efforts will not have been altogether in vain. But to each such happy individual he would express the hope that, as you have resembled Mr. Fuller in your experience of life, so may you emulate him in your liberality at death. In short, I would conclude almost in the words of old Bishop Andrews: Unum operæ meæ pretium abs te peto, hoc autem vehementer expeto, ut mei peccatoris meorumque in precibus interdum memor sis. Which being interpreted is: "'For these my efforts I beg but one thing in return, and this I beg most earnestly, *viz.* that you will now and then remember me a sinner against your patience and forbearance in your prayers, and that you will also be mindful of our professorships in your wills.'"

THE ROYAL INSTITUTION.

The following Table of the principle items of original work done by our Professors, taken in connection with their long series of laboratory notes, forms a monument of the intellectual activity, the manual dexterity, and the persevering industry, developed in the Laboratories of the Royal Institution:—

Davy.

1806	Chemical Agencies of Electricity.
1807	Decomposition of Potash.
1810	Chlorine.
1812	Discourse on Radiant or Ethereal Matter.
1813	Iodine.
1815–6	Researches on Fire-damp and Flame.
1817	The Safety Lamp.

Faraday.

1820	Alloys of Steel.
1821	History of Electro-magnetism.
,,	Magnetic Rotations.
1823	Liquefaction of Chlorine and other Gases.
1825-6	New Compounds of Carbon and Hydrogen.
1825–9	Manufacture of Optical Glass.
1831	Vibrating Surfaces.
,,	Magneto-Electricity.
1832	Terrestrial Magneto-Electric Induction.
1833	Identity of Electricities.
1834	Electro-Chemical Decomposition.
,,	Electricity of the Voltaic Pile.

1835	The Extra Current.
1837–8	Frictional Electricity.
"	Specific Inductive Capacity.
1845–8	Magnetization of Light.
"	Lines of Magnetic Force.
"	Magnetic Condition of all Matter.
"	Diamagnetism.
"	Magne-Crystallic Action.
1849–50	Magnetism of Flame and Gases.
"	Atmospheric Magnetism.
1856	Relations of Gold and other Metals to Light.
1860	The Regelation of Ice.

Tyndall.

1853	Transmission of Heat through Organic Substances.
1854	Vibrations due to Contact of Bodies at Different Temperatures.
1855	Researches on Diamagnetic Force.
1856	Slaty Cleavage.
1857–8	Physical Properties of Ice and Glaciers.
1859–63	Absorption and Radiation of Heat by Gases.
1865	Calorescence.
1866–7	Action of Heat of High Refrangibility.
1868–9	Formation of Clouds.
"	Colour and Polarization of the Sky.
1870	Smoke and Dust Respirator.

Frankland.

1863–6	Synthesis of Acids of the Lactic Series.
1863	Mercury-methyl, Mercury-ethyl, and Mercury-amyl.
1864	Transformation of Organo-Mercury Compounds into Organo-Zinc Compounds.
"	Combustion of Iron in Compressed Oxygen.
1865	Synthesis of Acids of the Acrylic Series.
"	Synthesis of Fatty Acids.
1866	New Organic Radical Oxatyl.
"	The Source of Muscular Power. Potential Energy in various kinds of Food.
1867	Source of Light in Flame. Effect of Pressure upon Luminosity of Flame.—*See* Mr. W. Spottiswoode's

Paper in the *Proceedings* of the Royal Society, Jan. 17, 1873.

PHILOSOPHICAL GUNNERY.

The *Philosophical Magazine* has an elaborate mathematical paper investigating the advantages arising from the employment in heavy ordnance of ever-changing angles of groove to receive a fixed angle of rifling in the shot. By this device, called an increasing spiral, a reduction of powder pressure in the chamber is shown to be effected to the extent of a hundred and sixty-fourth

part of the bursting force, as compared with the gun in which the angles of twist of the shot and bore coincide. It is also demonstrated that the mechanical force required to rotate the shot is a "small fraction" of that employed to drive it out of the gun. This "small fraction" is stated to be 2¼ per cent. of the expulsive force when the shot and bore correspond; whilst about one-half of this "small fraction" is required when their angles of rifling differ. In the majority of British rifled guns, and in all foreign ordnance, the angles of rifling in the shot and bore coincide throughout the whole length of the gun, to the loss of the above philosophical advantage.—*Hampshire Telegraph.*

HEMATITE IRON ORE.

A TRACT of Hematite Iron Ore has been discovered in Shropshire, and eleven hundred acres have been secured on behalf of certain Staffordshire ironmasters, who will work it as a company. Some specimens contain 57 per cent. of iron. The discovery is of great importance to the iron industry.

SPIEGELEISEN.

THE production of Spiegeleisen in this country is almost a new industry. At Ebbw Vale it has been manufactured from the Spathose iron ores of the Brendon Hills, and some has been made at two or three other works. Recently Messrs. Bolchow and Vaughan have, for the first time, made Spiegeleisen in the Cleveland district on a large scale, and preparations are being made for the construction of furnaces at Fowey, in Cornwall, for making this variety of iron from the spathose ores of Perranzabulo in that county.—*Athenæum.*

REFRACTION OF LIGHT.

MR. E. B. TYLOR sends to *Nature* an account of an interesting lecture-room illustration of the refraction of light, consisting of two small wheels connected by an axle, which are rolled from a smooth surface on to a rough one or *vice versâ.*

PRESSURE OF RADIATION.

SOME experiments exhibited by Mr. Crookes to the Royal Society seem likely to constitute a most interesting confirmation to physical theory. A light rod, having a small disc of pith at each end, was suspended by a delicate thread in a vacuum; on the approach of a body radiating heat (the finger, or a burning piece of magnesium wire) to one of the discs, it was repelled. A piece of ice appeared to attract the disc; this, however, is really a repulsion by the more heated bodies on the other side of it. If this experiment had been made fifty years ago, it would

have been regarded as conclusive in favour of the emission-theory of light. It had, however, been recently shown by Maxwell, that the propagation of waves through the ether produces a pressure in the direction of the ray, the pressure on a square foot of surface being equal to the whole energy of radiation in a cubic foot. Thus the pressure of strong sunlight is about three pounds and a quarter per square mile. "A flat body exposed to sunlight would experience this pressure on its illuminated side only, and would therefore be repelled from the side on which the light falls. It is probable that a much greater energy of radiation might be obtained by means of the concentrated rays of the electric lamp. Such rays falling on a thin metallic disc, delicately suspended in a vacuum, might perhaps produce an observable mechanical effect." ("Treatise on Electricity and Magnetism," vol. ii. p. 391). The amount of the pressure involved in Mr. Crookes's experiment must of course be measured before we can assert with confidence that it is actually pressure of radiation.—*The Academy.*

CELESTIAL SPECTROSCOPY.

Mr. Norman Lockyer has made to the British Association two important communications in connection with Celestial Spectroscopy. One is an account of the marvellous performances of a diffraction grating presented to him by its constructor, Professor Rutherford, of New York. It appears that this gentleman has, after years of labour, constructed a screw of wonderful perfection, by means of which he drives a ruling machine, and the mechanical details are now so complete that he can start the machine in the evening, leave it to itself all night, and find the ruling of the plate finished next morning. The grating exhibited by Mr. Lockyer was engraved on speculum metal, and had 6,300 lines to the inch. For equally high dispersion it surpasses a battery of prisms both as regards light and definition. When the fifth or sixth spectrum is used, the dispersion is so enormous that the 3 lines which compose the group *b* cannot all be comprised in the field of view of the telescope at once.

The other communication contains an account of inferences which have been drawn from an improved method of observing the spectra of electric discharge. When a spark is taken in hydrogen between two poles, one of iron and the other of copper, if a lens is employed to throw images of the two poles on the two ends of the slit, the spectrum of iron is seen at one side of the spectrum, the spectrum of copper on the other side, and the spectrum of hydrogen in the middle. It is thus easy to distinguish the lines of the metals from those of the medium in which the spark is taken. When one of the poles is of aluminium, it is found that two of the aluminium lines extend far beyond the rest, and the important fact is that these are the

only two aluminium lines which are found among the dark lines of the solar spectrum. Similar coincidences are found in the case of other metals, and one great difficulty in solar spectroscopy is thus removed. It thus appears (and the inference is confirmed by special experiments) that out of all the lines which a vapour emits when at a low pressure and not encumbered by the presence of other substances, portions are suppressed when other vapours are present in sufficient quantity, or when the vapour itself exceeds a certain density.

Kirchhoff, in one of his earliest papers, gave a conjectural explanation of the variations of a spectrum with the density of the vapour yielding it. This explanation may be accepted as true, so far as it goes, but it renders no reason for the difference which exists between the spectrum of a small thickness of a gas at high density and the spectrum of a great thickness at a low density. The chief explanation, according to Professor Clerk-Maxwell, is analogous to that which accounts for the difference between the sounds emitted by a bell—according as it is struck once, and then left to itself, or is rattled on with rapid blows of hammers, or is sawn at the edge with a metallic saw. In the first case, there is one preponderating note easily distinguished; in the second, a multitude of notes, which can only be distinguished by a highly trained ear; in the third, a frightful screech, which is analogous to a continuous spectrum.

M. Janssen, who has of late years been one of the most regular attendants at the meetings of the British Association, gives, as usual, a valuable contribution to solar observation, by describing (in French) a plan for applying photography to the determination of the precise times of beginning and ending of the approaching transit of Venus. A disc, with an intermittent motion of rotation about its centre, is to carry upon its face upwards of a hundred photographic plates disposed in concentric rings, and successive pictures of the sun will be taken, one upon each of these plates, at the commencement of the transit, and again upon another set of plates, similarly mounted, during the concluding portion of the transit.

PHOTOGRAPHIC RESEARCHES.

A PAPER has been read to the Photographic Society, by Capt. J. Waterhouse, "On Photocollotype Printing," in which the use of citric acid was recommended as a clearing agent. Lieut. Chermside, R.E., read a paper "On Photography in the Arctic Regions." The author accompanied Mr. L. Smith in his Arctic expedition last summer. The temperature at which pictures were actually taken was rarely below 32° Fahr., but much difficulty was experienced in maintaining the solutions in proper order during excessive cold. The author gave some practical advice on the subject of overcoming natural difficulties inherent to photographic manipulations in high latitudes.

Prof. Henry Draper, of the University of the city of New York, sends us a copy of his paper "On Diffraction Spectrum Photography, illustrated by a Photograph printed by the Albertype Process, by Mr. E. Bierstadt." The paper is itself an acceptable contribution to science, but the photograph is of great value. The spectrum was taken on a collodion plate, and transferred by the Albertype process to a thick piece of glass, from which the plates are printed; the spectrum, we are assured, is absolutely untouched, the lines of the solar spectrum being correctly represented in their relative positions as printed by themselves.—*Athenæum.*

THE BEGINNINGS OF LIFE.

Dr. Bastian's great work on "The Beginnings of Life" continues to attract much attention in scientific circles. The doctrine which the author urges is the possibility of deriving living beings from dead organic matter, and to this species of transformation he gives the name of *archebiosis.* He shows that *bacteria* are generated in liquids in which no germs can be discovered under the highest microscopic powers, and he thence concludes that they must either be derived from invisible germs, or that they have been produced in the fluid by a process of archebiosis. He also shows that bacteria are killed by heat, but that they are nevertheless developed in liquids which have been raised to the boiling point. These results, it must be confessed, are not conclusive. But the doctrine of archebiosis, or of spontaneous generation, as it is sometimes called, has acquired a new authority when it has such men as Dr. Bastian arrayed in its support.—*J. C. Bourne, Illustrated London News.*

STUDY OF MAN.

From a preliminary Report, presented to the British Association by Colonel Lane Fox, we learn that an elaborate scheme has been drawn up, comprising one hundred sections, relating to all that it seems possible to know about a man—his physical constitution, his history, his social condition, and what not. This scheme, descending to the minutest details, seems framed so as to satisfy even the most thorough-going anthropologist. Each section is prepared by an eminent authority, and tells the traveller what questions to ask and what to observe for himself. If only a tithe of these observations are made, science must needs be greatly aided, and instead of having travellers' stories we shall get sober facts. But the traveller, following the instructions, must record his answers as he receives them on the spot, and not rely on recollection, which generally leads to distortion of the truth. It has been well said that "half a word fixed upon or near the spot is worth a cart-load of recollection."

ETHNONOGICAL SPECIMENS—A SOUL-TRAP.

The Rev. Wyatt Gill deserves special mention for exhibiting and describing to the British Association a highly-interesting collection of ethnological specimens, collected by him during a long residence, as missionary, in the group of the Harvey Islands, in Polynesia. Perhaps, one of the most curious of these objects—one which we do not remember to have previously seen represented in this country—was nothing less than a Soul-trap! This consisted simply of a series of rings, twisted in cocoa-nut fibre. If a native should commit a great offence, or have the misfortune to offend a sorcerer, the latter immediately proceeds to make a new ring in his chain, so as to form a trap to catch the poor man's spirit. This ring is then hung up in the open air; and if a butterfly or small bird chance to fly through it, the sorcerer asserts that the soul of the culprit, assuming this form, has passed into the trap. It is immediately known throughout the tribe that a certain man has lost his soul, and his friends consequently seek to propitiate the medicine-man by bringing to him large presents. If the offence has not been great, this is easily accomplished, and the soul is easily induced to return; but, if the sorcerer does not choose to be influenced in this way, and refuses to call back the soul, the fate of the unhappy offender becomes pitiable indeed. As a matter of fact, it invariably happens that the soulless man shortly afterwards dies, of course through sheer mental distress at having had his soul thus entrapped.

ANIMAL PHYSIOLOGY.

In *Der Naturfarscher* we note two striking observations in Animal Physiology. One of these refers to the torpedo, which has been a puzzle to physiologists, inasmuch as, while giving shocks strong enough to lame or kill another animal, its own muscles do not show the least contraction. Du Bois Raymond's hypothesis is, that while the stimulation to discharge goes forth from the central organ, the same organ sends out at the same time a counteractive influence through the nervous system, which neutralises the excitability of the nerves. M. Franz Boll took a recent opportunity of experimenting with the fish on the Italian coast, and, among other things, he tested this theory by cutting some nerves, and watching their muscles when he stimulated the electric nerves. The neutralising stimulation being thus cut off, the muscles should, he thought, contract, if the hypothesis were true; and they did so, the muscles of the unsevered nerves remaining at rest. Still, he hardly thinks the experiment decisive, because nerves are more excitable after section.—The other observation is by Professor Fick, who has found, by manometric measurement, a less pressure of blood in the left ventricle than in the aorta; 80 mm. of mercury in the

one case, 104° to 128 in the other (in a dog). He supposes the blood, only partially filling the ventricle, at the apex, to be shot against the semilunar valves, forcing them open by its *vis viva*. In the neighbourhood of the valves the pressure must quickly rise. In short, as the author puts it, the blood is not pressed, but hurled (*geschleudert*) into the aorta.—*Nature.*

PHYSIOLOGY OF THE BRAIN.

At the Annual Medical Conversazione held at the West Riding Asylum, Wakefield, on the invitation of Dr. Crichton Browne, medical director of the institution (in which there are 1,400 inmates), a large number of medical men of Wakefield, Leeds, Bradford, and other towns assembled to hear the lecture by Dr. W. Carpenter, Registrar of the London University, on the recent advances in the study of the Physiology of the Brain, with special reference to experiments conducted by Professor Ferrier, of London, tending to show the localization of the functions of the brain. These experiments were first made by Professor Ferrier at the West Riding Asylum, and have given rise to much thought and discussion in the medical world. It is believed that the results will occasion a very great change in the treatment of the various forms of mental disease. We are in a position to state that Professor Ferrier is at present engaged in conducting a series of experiments on the brains of monkeys in particular, for which purpose a grant has been made to him by the Royal Society, before which body he has read a paper embodying the result. The fact that he was to repeat several of his wonderful experiments gave additional importance to the proceedings. Lord Houghton, in introducing Dr. Carpenter, said he was much honoured by being permitted to take the chair at a meeting of so many eminent scientific men in a locality with which he was connected both by family associations and by political, social, and administrative relations. They would have before them that evening one of the most eminent of modern physiologists, and he would tell them, in words which he would not venture to anticipate, that interesting experiments were still going on in relation to the study of physiology, and those peculiar and wonderful operations which were implicitly connected with their mental functions, and which exhaust all that enormous sphere of interests which occupied the province of human intelligence. He could do no more than ask them, as he knew they would, to give to Dr. Carpenter a most respectful hearing, and to continue each of them in their own studies, and, as far as circumstances would permit them, to follow out those illustrations he would give them of experiments which had been made by many eminent physiologists in that very place itself; and in telling them to do so he would ask them to act with two principles—with courage and with caution—because it was necessary to remember that,

as in the old time, human ignorance and human superstition had such power over the minds of men that even such a discovery as that of anesthetics, relieving mankind from an enormous load of pain, was overcome by that superstition and that ignorance, and remained for four centuries buried, till it was re-discovered by the science of to-day. They would every one of them be met by certain difficulties in their own processes which it would require courage and caution to meet. There was no doubt that in the treatment of the insane lay the deepest and the most serious means of discovering those varieties of physiological processes connecting themselves with physiological phenomena, and leading on to discoveries of what perhaps they themselves had at that moment only the slightest apprehension. They would find objections from people telling them those things were wrong, that they must not try them; and therefore those objections were to be met with caution and with courage. Go on, he would say, with the truth when they knew they had got the truth. Go on with moderation, and that certainly would lead them to understand—what it was the duty of every medical student to understand accurately—not only the structure and functions of the body, but also, through the processes of the brain, of gaining such understanding as he might of the connexion of the mind with the body of man. Go on in that way, and they would each of them, as far as their intelligence and study permitted them, add not only to the science of their country, but the greatest of all science which a man could understand—the science of man. Dr. Carpenter then gave a lecture, which was an extension of those which he recently delivered in St. George's Hall, London.—*Times*.

THE NERVOUS SYSTEM.

No fewer than five papers on physiological subjects, relating chiefly to the nervous system, are contributed by Prof. Cyon to the last number of Pflüger's *Archiv für die gesammte Physiologie*. This journal also contains an account of some experiments, by Herr B. Luchsinger, "On the Formation of Glycogen in the Liver." The experiments were conducted in the Physiological Laboratory of the University of Zurich, and supplement those of Weiss on the production of glycogen when glycerine is injected into the system.

PRESERVATION OF HEALTH ON THE GOLD COAST.

THE following suggestions have been furnished to the *British Medical Journal* by an experienced medical officer:—1. Good water being of the first importance, the following rules should be observed as far as possible. The water should be boiled and filtered, but the best way to use water, and for thirst, is to drink it with tea. It is strongly recommended that all

ranks fill their water-bottles with tea, and use it in preference to plain water. Water should always be drunk in moderation when the body is heated. The less a solder drinks when on the march the better. 2. Flannel shirts should invariably be worn. No linen or cotton shirts should be used. The most experienced officers in such climates have all recommended flannel. The best writers on the hygiene of the tropics (Chevers, Jeffreys, Moore) all recommend flannel. From experience at Rome and the West Coast of Africa, it is protective against malaria. 3. All ranks are warned against intemperance. The men who drink spirits to excess are the first to fail when strength and endurance are required, and they are less likely to recover from disease, wounds, and injuries. 4. Great care should be paid to the feet. At the close of a day's march every man should bathe his feet, and wash his socks whenever they are soiled. If the feet chafe, rub the socks with common soap where they come in contact with the sore places. Rubbing the feet with oil or fat of any kind before marching is a good remedy. If blisters form on the feet, they ought not to be opened during the march, but at the end of the time a needle and thread should be drawn through, and the fluid will gradually oose out. 5. An old and experienced soldier eats and drinks as little as possible while marching. The young soldiers are warned against eating the contents of their haversacks and using their water-bottles on the line of march. It is a bad habit, and causes more suffering in the end. 6. At the halt, or at the end of a day's march, the heated men should not uncover themselves. They should take off their valise and belts, but keep on their clothes for an hour. Then they may be taken off, well shaken, and dried. This will prevent the danger of chill and exposure. 7. Quinine, as a daily article of diet and not as a medicine, is recommended. It should be taken every morning, to the extent of as much as will lie on a halfpenny. 8. Men should never march on an empty stomach. Tea or coffee and bread should invariably be taken before commencing the morning's march or work. 9. Camp fires should be allowed whenever admissible. They purify the air, prevent annoyance from insects, dry clothing, and are a security against chilliness during the night. 10. Perhaps in no expedition ever undertaken by this country will greater vigilance be required over health matters than on this to the West Coast of Africa. It behoves, therefore, all ranks to aid and assist the commanding officer in maintaining the battalion in the highest physical efficiency.

FORCE AND MOTION.

Dr. William Rutherford, the new Fullerian Professor of Physiology, begins a course of twelve lectures on the Forces and Motions of the Body. In his introductory remarks he com-

mented on the various modes of motion going on in the living body—mechanical, electrical, thermal, sonorous or vibratory, and chemical; and he then proved by experiments that all these motions may be transformed into each other—mechanical motion giving rise to electricity heat, and sound, and the converse. Having alluded to atomic, molecular, and molar motions, he stated that all motion results from the action of force, the nature of which is unknown, but which has been defined as causing and suspending motion, or changing its direction. He then characterised and illustrated the forces of gravity, chemical affinity, cohesion and adhesion, as well as the dual or polar forces of attraction and repulsion exhibited in electricity and magnetism. Energy was described as different to force, but implying its existence, and as being the power of doing work. When a weight is raised by a cord, it acquires energy, which is termed potential till the weight is let fall, when the energy is termed kinetic. The potential chemical energy of a lucifer-match is changed to kinetic by friction. Proceeding then to the subject of his course, the Professor stated that the ordinary mechanical motions of the body are mostly due to forcible changes in the shape of the contractile tissues, which may or may not be prompted by nervous action, the direction of these motions being either indefinite or definite. Motion in an indefinite direction, which is found in the corpuscles of white blood, mucus, and connective tissue, was termed amœbiform, from its similarity to the movements of the protamœba and amœba, the lowest forms of animal life, being masses of mere jelly or protoplasm. Motion in a definite direction was illustrated by reference to the movements of the pigment-cells of the frog and of the animalcules named bacteria, and also in the ciliary motion observed in the gills of the oyster and mussel, which also occurs in the higher animals. Several of these interesting phenomena were exhibited on the screen by the aid of the microscope and the electric lamp.—*Proceedings of the Royal Institution.*

MUSCULAR MOTION.

PROFESSOR RUTHERFORD, in his third lecture on the Forces and Motions of the Body, given at the Royal Institution, describes the nervous mechanism concerned in voluntary and involuntary muscular movements. In speaking of the rapidity of muscular action, he alluded to the fact that striped muscle is placed in those parts of the body where quick action is required; thus, in the upper part of the gullet, where the food must pass rapidly, in order not to interfere with respiration, the muscular fibre is striped; while in the lower part, where such quickness is not needed, this fibre is non-striped. He then threw the shadow of a frog's muscle upon the screen, and showed that the amount of contraction produced varied: 1, with the power of the stimulus (electricity) used to throw it into contraction; 2, with

the weight which the muscle was caused to raise; and 3, with the energy of the muscle, an exhausted muscle being unable to raise any weight at all. He also pointed out the perfection of muscle as an apparatus for the production of mechanical motion, since a little muscle of the frog's leg is able to raise a weight of fifteen ounces. He mentioned that the contractile substance of a muscle is semi-fluid during life, and stiffens at death, and in so doing it separates in a solid and fluid part. The solid part consists of myosin, a substance resembling albumen in composition; while the fluid part contains small quantities of numerous other constituents found in muscle. The solidification of myosin is the cause of "rigor mortis," or death stiffening.

DEATH AND THE SEASON.

It is well known that the rate of mortality differs at different seasons of the year. The Scottish Registrar-General has examined the registers with a view to ascertain the relative effect which season has upon the mortality at various ages. The examination was confined to the deaths registered in the ten years 1856-65 in the eight principal towns of Scotland; but these contain very nearly a third of its population, and the facts they exhibit as to the influence of season are regarded as showing the effect upon Scotland generally. Dividing the year into two equal parts, the mortality as a whole is seen to be greatest in the winter and spring, and least in the summer and autumn; but the most fatal month of the season and the extent of the influence of season vary with age. Equalising the months to 31 days for comparison, it is found that the mortality of children under five years of age was least in September and greatest in February, and that the deaths in the ten years ranged from 8,649 in September to 11,165 in February. At the next age taken, from 5 to 20 years old, there is less variation in the monthly number of deaths than at any other period of life; August was the month of least and February the month of greatest mortality, and the range was from 1,929 deaths in August to 2,348 in February. Among persons between 20 and 60 years of age, the vigorous period of life, September was the month of least and January the month of greatest fatality; and the range was from 4,724 in September to 7,033 in January. The returns relating to persons above 60 years of age show the baneful effects of cold; the least fatal month was September, the most fatal was January.

STEAM GOVERNORS.

In the *Journal of the Franklin Institute* appears a useful paper by Mr. Hugo Bilgram, on the theory of Steam Governors. In government reports on the decay and preservation of timber,

Generals Cram and Gillmore recommend the Seely process as the best. In consists in subjecting the wood to a temperature above the boiling point of water, and below 300° Fahr. while immersed in a bath of creosote a sufficient length of time to expel the moisture. When the water is thus expelled the pores contain only steam; the hot oil is then quickly replaced by a bath of cold oil, by means of which change the steam in the pores of the wood is condensed, and a vacuum formed into which the oil is forced by atmospheric pressure and capillary attraction. Gen. Gillmore thinks a wooden platform, *thoroughly creosoted*, would last twenty to thirty years, and be better than a stone platform during that entire period.

SCIENTIFIC USE OF THE IMAGINATION.

PROFESSOR TYNDALL, in a lecture given by him before the British Association, has given some few illustrations of the value of a duly controlled imagination mentally picturing the invisible. Standing on the deck of the *Irene*, he said, and listening at different times to the sounds, it was evident to all the party that there was a something which caused these variations, something which had a real existence, something invisible which it was for the imagination to picture. The Professor proceeded to speak of the passage of heat through different bodies, and mentioned the almost perfect stoppage of heat by some, and its ready transmission by others. Imagination has to picture vapour from sea and land arising in the air in layers, these layers presenting "reflecting surfaces" to the passage of sound. In the relative homogeneity of the atmosphere, or its being split up into many layers, we have a clue which may enable us to arrive at a knowledge why sounds of equal intensity will travel further on some days than others. The Professor explained some instruments called "cyrens" in use in America, and also read some extracts from Faraday's correspondence with the Trinity House on the subject of sound signals.—*Builder.*

REVOLUTIONS OF SCIENCE.

IT is not often that Mr. Disraeli says anything which calls for particular notice in a journal of this kind; therefore it is with peculiar pleasure that we quote the opinion he uttered at the late Glasgow banquet as to the share which Science has had during the present century in moulding the world. Coming from a man of his shrewdness and sentimentality withal, the words have a striking force. Speaking of the last fifty years, he said:—"How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of empires, the change of dynasties, the establishment of Governments. I am thinking of those Revolutions of Science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes and all the legislators that ever lived."—*Nature.*

Electrical Science.

THE ATMOSPHERIC TELEGRAPH.

The *Times* of Nov. 15, 1873, contained an article on the Pneumatic Despatch, which has never been used to any extent in this country. From that article we learn the following particulars as to the working of the above method of conveyance in London:—

The pneumatic tube extends from the London and North-Western Railway Station at Euston Square to the General Post Office in St. Martin's-le-Grand. The central station is in Holborn, where is also the machinery for effecting the transit of the trains. Here the tube is divided, so that in effect there are two tubes opening into the station, one from Euston to Holborn, and the other from the Post Office. The length of the tube between Holborn and Euston is 3,080 yards, or exactly a mile and three-quarters, a greater length than was originally contemplated, but which was rendered necessary by the avoidance of certain property on the route. The tube is of a flattened horse-shoe section, 5 ft. wide and 4 ft. 6 in. high at the centre, having a sectional area of 17 square feet. The straight portions of the line are formed of a continuous cast-iron tube, the curved lengths being constructed in brickwork, with a facing of cement. The gradients are easy; the two chief are 1 in 45 and 1 in 60, some portions of the line being on the level; the sharpest curve is that near the Holborn station, which is 70 ft. radius. The tube between Holborn and the Post Office is 1,658 yards in length, or 102 yards less than a mile, and is of the same section, and similarly constructed to the first length. Two gradients of 1 in 15 occur on the Post Office section, but this steep inclination is in no way inimical to the working of the system. The Holborn station is situated at right angles to the line of the tubes, which are therefore turned towards the station into which each opens. All through trains, therefore, have to reverse there, and this is effected in a very simple manner by a self-acting arrangement. A train upon its arrival runs by virtue of its acquired momentum up a short incline, at the summit of which it momentarily stops, and then quickly descends by gravity. In its descent it is turned on to a pair of rails leading to the other tube, into which it enters and through which it continues its journey, the whole process of reversing occupying barely 30 seconds. Trains containing goods for the Holborn station are simply run down from the top of the incline on to a siding.

The waggons, or carriers, as they are termed, weigh 22 cwt., are 10 ft. 4 in. in length, and have a transverse contour con-

forming to that of the tube. They are, however, of a slightly smaller area than the tube itself, the difference—about an inch all round—being occupied by a flange of indiarubber, which causes the carrier to fit the tube exactly, and so to form a piston upon which the air acts. The machinery for propelling the carriers consists of a steam-engine having a pair of 24-in. cylinders with 20-in. stroke. This engine drives a fan 22 ft. 6 in. in diameter, and the two are geared together in such a manner that one revolution of the former gives two of the latter, or, in technical terms, the engine is geared at 2 to 1 with the fan. The trains are drawn from Euston and the Post Office by exhaustion, and are propelled to those points by pressure. The working of the fan, however, is not reversed to suit these constantly varying conditions; it works continuously, the alternate action of pressure and exhaustion being governed by valves. The engine takes steam from three Cornish boilers, each 30 ft. long and 6 ft. 6 in. in diameter. Telegraphic signalling is carried on between the three stations by means of needle instruments.

The system of Pneumatic Despatch, or "Atmospheric Telegraph," as the French call it, is utilised to a much greater extent in Paris than in London, though with some important differences in construction and object. We have thought that some details concerning the working of this system in Paris might be useful and interesting at the present time, and we therefore give an abstract of some articles on the subject which have recently appeared in *La Nature*.

The question of the distribution of messages in the interior of towns has revived the systems of pneumatic transport, which, after having had their day of celebrity, seemed for twenty years doomed to oblivion.

In following the aspects of this question, we shall show in what way the atmospheric telegraph is a result of the electric telegraph. We shall afterwards consider the former more specially; and after having shown its present condition, shall inquire what future is in store for it.

The telegraphic despatch has become an article of everyday use. As the age is a fast one, it is natural that it should utilise with eagerness so handy a means of transmitting almost instantaneously its impressions or its wishes to all distances. It is necessary to remember that a city like London or Paris sends out and receives every day an immense number of telegrams. The wires which serve as conductors of electricity are multiplied in all directions for the purpose of meeting the demands of this traffic. They meet in the interior, at the central office. This central station speaks *urbi et orbi*; in other words, it receives the messages of the city for the purpose of spreading them over the entire world, and it accomplishes also an inverse movement. The aspect with which we are here concerned is the distribution

throughout the city itself. Let us see what has been done in Paris to accomplish this purpose.

As each house cannot be put in immediate communication with the telegraphic network, it became necessary to adopt some other convenient plan. In the case of Paris, the city is divided into districts of a mean radius of 500 metres, in order to limit the journeys of the foot-messengers. The application of this rule gave fifty points, distant one kilometre from each other, where are established so many branches of the chief office.

This system was found, however, not to work well, and was moreover very expensive, for reasons which we need not detail here; and after *voitures* were tried for some time as a means of sending despatches from the head office to the more important branches, it was resolved to have recourse to the pneumatic tube. We have just referred to the extent to which it has been carried in London. Paris and Berlin followed the example of London in 1865. We shall speak here of the system of Paris.

In Paris there are fifty stations, distant from each other about a kilometre, connected by an iron tube, which is interrupted at each station. The central station, by which the transit of messages is effected with the interior, is in the Rue de Grenelle; there are seventeen district stations, in the Rue Boissy-d'Anglas, Grand-Hôtel, Bourse, &c.

How is this network managed? Like a diminutive subterranean railway, in which the waggons are cylindrical boxes and the motive power compressed air prepared in the stations. At the central bureau the trains are formed, composed of as many boxes as there are branch offices to supply. The trains are *omnibus* when they stop at the intermediate stations, *express* when they shoot past them.

Every quarter of an hour an omnibus train leaves the Rue de Grenelle, and accomplishes the distance which separates it from the Rue Boissy-d'Anglas (1,500 metres) in a minute and a half. There it is received in a vertical column, and the box which carries the messages to be distributed in the district having been taken out, the others are put into the section of the line which runs towards the Grand-Hôtel, a new box having been added containing messages to be transmitted, which have been deposited since the last train. The train again takes its departure, composed of as many boxes as before; it goes through the same operations at the Grand-Hôtel, the Bourse, the Théâtre Français, and at the Rue des Saints-Pères. It re-enters the Rue de Grenelle twelve minutes after its departure, having changed all its boxes and carried back messages for distribution.

Besides this there is a secondary network, the details of which, however, we need not now enter upon. There is a direct line which goes from the Rue de Grenelle to the Bourse, and to branches in the Champs-Elysées, the Place du Havre, and the Rue des Halles. On the first run the express trains going and returning, the departures of which are intercalated

between those of the omnibus trains, for the purpose of supplying those stations which are busiest, twice every quarter of an hour. The departure is accomplished by pressure, the return by aspiration. The same method of working is applied to the branches, which correspond with the omnibns trains of the principal network.

The tubes which compose the lines are of iron, the interior diameter being 0·065 metre. They are connected by bridle-joints (*à brides*), and admit of curves having a radius of from 5 to 20 metres.

Various systems for the production of compressed or rarified air are employed. The first in date is an application of the principles of the apparatus known as Hero's Fountain. Atmospheric air is decanted from a first receiver into a second receiver communicating with the first by means of a tube, by the introduction of water into the receiver. The air thus forced is drawn into the receiver for the purpose of being dispersed in the tubes. Where the machines are not allowed to be used, the employment of steam is much more economical for the compression of air. Recourse is then had to ordinary pumps, which insure an active service and are subject to fewer causes of irregularity.

Trains composed of ten boxes weigh about four kilograms; they are either pushed or sucked along by a difference of pressure of three-fourths of an atmosphere, which gives a mean speed of a kilometre per minute.

The travellers which take their places on the Lilliputian carriages already described are closed envelopes containing messages; they are piled in groups of thirty or forty in a *curseur*, or box. This box is formed of two cylinders, the interior one of sheet iron, the outer one (enveloping the former) of leather. To make up a train a piston must be affixed after the last box, for the purpose of enabling the compressed air to take effect. The piston is a piece of wood provided with a leather collarette, which assumes the shape of the interior of the tube, and forms an almost hermetical joint, without much friction.

The apparatus at first adopted for receiving and despatching the boxes having been found neither sufficiently rapid nor convenient, a much more complete system is now employed. Two lines enter the office, each attached to separate apparatus. In the first place, for the purpose of despatching messages, a man opens the door by means of a lever; the boxes and the piston are thrown into the tube, and await at the bottom the current of air which will propel them. This current is produced as soon as the cock is opened which commands the head of the apparatus opposite to the tube. The cock distributes the air upon the second line. In the second place, the receiving door is opened by a second attendant, who finds the train at the station, and takes out the boxes in order to bring the telegrams

to light. The entire apparatus has somewhat the form of a cannon, only the effect is more blessed. The artillerymen are not exposed to death; the worst accident they have to fear is the bursting of the tube.

The messages are divided into two classes—questions and answers, orders and the executions and orders which can at once be exchanged between any point of the city and any point of the interior, in the province, or abroad, or inversely. All that is necessary in this case is a centre—as the Hôtel des Télégraphes, in the Rue de Grenelle, is called—connected in the one part with the exterior with the network of electric wires, and with the interior in the network of pneumatic tubes. These tubes are, moreover, well adapted for the service of the local post, and for the exchange of messages within the city.

TRAIN SIGNALLING.

CAPTAIN TYLER, on behalf of the Board of Trade, has inspected the working of Colonel Binney's system of train communication as applied to a Great Eastern Railway train. This system is on the electrical principle. Briefly, it consists of a communication fixed in each compartment of the carriage, and a battery and bell in the front and rear guards' vans. On pressing a stud in the carriage, the guards' bells are rung electrically, and two discs are mechanically projected outside the carriage—one on either side—from which the signal was made. A portion of the communicating mechanism is brought into view by the act of signalling, and acts as an indicator of the compartment whence the signal was sent. The special feature of the invention, beyond the simplicity of the arrangement, is that the two conductors are connected, one with both positive poles and the other with both negative poles of the batteries, and until contact is made no current can pass, and consequently no waste is going on in the batteries. By Colonel Binney's system passengers can communicate with guards, and guards with each other and the engine-driver, in a simple manner. All this was exemplified at the trials which were made in the presence of Captain Tyler, Colonel Rich, and a number of railway engineers and managers. The general opinion was in favour of the system, the signalling being carried on in a very rapid and effective way. Colonel Binney showed how, that if a train parted by accident, the fact would be notified to the guards by the coupling of the conductors making contact with the metallic cover of the joints, or the coupling be pulled taut before givin g way. This would complete the circuits and ring the guards' bell.—*Engineering*.

THE ELECTRIC TELEGRAPH AT THE GOLD COAST.

Private advices from the Gold Coast state that a large number of men of all colour, castes, and creeds are employed under the Royal Engineers in the construction of the land telegraph lines. · Wherever it is practicable, trees are substituted for telegraph posts without cutting them down. By means of the light wire and small insulators sent out from Henley's Telegraph Factory at North Woolwich, these men, with no other tools than a light ladder, large gimlet, a hand-saw and axe, can complete six miles of line per day, when the way is tolerably clear through the bush. The number of insulators and tree posts per mile varies according to the nature of the ground. The average on level ground is 18 intermediate and three straining posts per mile, which makes a span of 84 yards, and on hilly and difficult ground there are as many as 26 posts to the mile, and in exceptional instances there are spans of 200 yards. Where wooden posts are used, not one in 20 of the native allies can fix them in their places straight, or capable of resisting the action of the wind or the effects of rain. It has been found in the experiments recently made at Chatham by the telegraph engineers, that the instruments required for an efficient military or field telegraph are different from those in ordinary use. Those sent out in the steam-transports from the Royal Arsenal, Woolwich, possess the following advantages:—Compactness and portability, rapidity and correctness in action, readiness at all times for immediate use, possessing their own source of electrical power independent of liquid batteries, not easily deranged by rough usage or rapid transport, and capable of being worked by any ordinary staff without previous training. The difficulty of transporting acids and chemicals at the Gold Coast, and the frequent absence of water and the evaporation which occurs in tropical climates, rendered the employment of batteries impracticable. There were also difficulties in providing a trained staff with the needle instrument using the dot and dash of the Morse alphabet, while in the vicissitudes and reprisals of war there was a chance of the sudden removal, or death from wounds, or sickness, of the operators engaged working the instruments. The telegraph apparatus employed in the Gold Coast Expedition against the Ashantees is the invention of Sir Charles Wheatstone, and is contained in a compact box, 13 in. long, 8 in. broad, and 7 in. deep, the weight of the whole being under 25 lbs. The electric power is derived from a permanent magnet within the instrument, a constant series of currents from which is obtained by a rotation of a small iron armature placed before its poles and turned by a handle in front. The signals are made by successive depression of lettered fingered keys arranged round the dial plate. These depressions release the key previously depressed, and automatically regulate the distance through which the

pointer has to move in order to indicate the required letter. By means of these instruments, camp and field messages can be transmitted, at the rate of 20 words per minute, a distance of 100 or 200 miles. The object in erecting the field telegraphs is that of making known the enemy's position or numerical strength, to order arms and reinforcements from distant stations, and to control any military and strategic movements found necessary in the war on the Gold Coast with the Ashantees. It is the first time field telegraphy has been employed by the English in actual warfare.—*Times.*

POSTAL TELEGRAPHY.

Our postal and telegraphic systems, in regard to their general management, stand out as excellent examples of what clever organisation may accomplish, even under the auspices of government, and present a striking contrast with the management of our naval and military services. From a recently issued Report of the Postmaster-General, it appears that there was a steady and large increase of postal telegraphic business during 1872. The number of new offices opened was 305, making a total for the United Kingdom at the end of the year of more than 4,500. The number of ordinary messages transmitted during the year was 14,858,000, showing an increase of 3,098,000 on 1871. The total number of words was 28,024,770 in 1872, sent for press messages alone. On some occasions upwards of 200,000 words, equal to about 100 columns of the *Times*, have during the Parliamentary Session been transmited in a single night to a principal press. The entire length of the wires at the end of 1872 was over 105,000 miles, of which about 5,000 miles was rented by private firms, the latter paying an amount of 38,000*l.* for the privilege. The telegraph instruments, chiefly Wheatstone's needle and the Morse, numbered 7,500. Some very interesting details of special instances of telegraph work are mentioned, as in the case of races, public fêtes, the Autumn Manœuvres, &c. As a recent feat of the department may be mentioned the transmission of *verbatim* reports of Mr. Bright's speech at Birmingham to most of the leading towns in the United Kingdom. Upwards of 100 press messages, addressed to upwards of 50 different newspapers, were sent, containing in all over 160,000 words, but the actual total of words sent was over half a million. Of course special arrangements were made by employing picked operators, so as to secure the publication of the reports in the early edition of the following day's papers. The staff of officers exclusively engaged on telegraphic duties at the end of 1842 consisted of 9,591 persons, including engineers, operators, messengers, and others. The financial results showed a large profit between receipts and expenditure.—*Times.*

THERMAL CONDUCTIVITY.

Two papers have been read to the British Association, describing experiments by the authors on thermal conductivity. Professor Herschel's method consisted in measuring the quantity of heat transmitted in a given time through a stone disc, whose lower face was in contact with water at a constant high temperature, while its upper face was in contact with water, which was raised in temperature by the heat transmitted. Professor Forbes's method, when applied to determine the conductivity of ice, consisted in observing the quantity of ice formed in a given time beneath a thin metallic vessel containing a freezing-mixture. While the ice is forming, its lower surface is certainly at zero, and its upper surface is assumed to have the same temperature as the freezing-mixture.—*Athenæum.*

PLAN BY TELEGRAPH.

M. Dupuy de Lome has exhibited, at the Academy of Sciences, Paris, an invention for sending a plan or topographical sketch by telegraph. Over the plan or map is placed a semicular plate of glass, graduated. On the centre is a radial arm, also graduated, which carries on a slide a piece of mica with a blade point. A fixed eye-piece is adjusted, and, looking through this, the mica point is carried successively over all the points of the plan to be reproduced, and the polar co-ordinates of each noted. The numbers thus obtained are transmitted by telegraph, and they are laid down by the receiver, who uses a similar arrangement to that which we have briefly described.—*Ibid.*

THE LEYDEN BATTERY.

A paper on the duration of discharge of the Leyden Battery, by Herr P. Reiss, is published in Poggendorff's *Annalen.* The author maintains that the time occupied by the discharge is, in general, not the same as the duration of the spark. The same journal contains a description of a plate electrical machine on Holz's principle, but apparently of much simpler construction, recently devised by Herr Leyser.—*Ibid.*

THE POLARIZATION OF PLATINUM ELECTRODES.

Professor Helmholtz, of Berlin, has communicated to the Royal Prussian Academy of Sciences a valuable paper, descriptive of his researches on the Polarization of Platinum Electrodes employed in electrolysis. This paper appears in a recent number of the Academy's *Monatsbericht.*

THE ELECTRIC LIGHT AT WESTMINSTER PALACE.

Some experiments have been carried out under the direction of Dr. Percy with the apparatus for producing the Electric

Light to be exhibited from the Clock Tower of the Houses of Parliament. The experiments were made in the vaults beneath the House of Commons, where a long range of view was obtained. The apparatus for producing the light is Gramme's magneto-electric machine, to be presently described. Briefly, it consists of three iron rings encircled with coils of copper wire, which revolve on a horizontal shaft between the two poles of strong magnets. By employing this rotary action a continuous magneto-electric current is obtained with a very small expenditure of power. The apparatus for producing the light consists of the ordinary carbon points, with mechanism for adjustment and for following up the reduction of the carbon by combustion. The light is thrown through a dioptric lens 21in. in diameter, manufactured by Messrs. Chance, of Birmingham. The apparatus is mounted in a casing which is pivoted at the front, and has a screw adjustment in the rear, by which the light can be elevated or depressed. At the side is gearing by which horizontal adjustment can be effected, the combined arrangement being somewhat similiar to that used for training guns. This apparatus is to be placed on the north side of the Clock Tower, and should the light prove a success the present arrangement will be superseded by a permanent apparatus of modified character. In it Messrs. Chance's fixed light lenses will be employed, by which means the rays will be diffused through an arc of 180 degrees. The experiments consisted in showing the power, steadiness, and purity of the light, by throwing it along a corridor 300 feet in length, and also in manipulating the elevating and depressing screw as well as the lateral training gear. Dr. Percy explained the arrangements. The machine used is that which was shown at Messrs. Whieldon and Cooke's works, and it is driven by an engine near the boilers under the House of Commons. From the electric machine two half-inch copper-wire conductors are led for a distance of 400 feet along the vaults, and then for a height of 260 feet to the top of the clock tower. The reason for the great horizontal length is that the motive power is so far from the base of the clock tower.—*Times.*

MEYER'S MULTIPLE TELEGRAPH.

M. Meyer, the well-known inventor of the automatic telegraph, has devised an apparatus, to which he has given the name of the Multiple Telegraph, and with which he can transmit simultaneously several messages by one wire. This simultaneity, however, only applies to despatches taken together, because the wire is only traversed at a given instant by a single current, developing a given sign.

The invention of M. Meyer is based on the fact that if we consider an ordinary telegraphic instrument, the Morse, for example, the apparatus does not send a continuous current, but a series of currents, which mark points and lines on a band of

paper. The intervals between these points and lines correspond to the movements when no current traverses the line. These periods of cessation M. Meyer seeks to utilise in order to send a second, and even a third or fourth despatch. To effect this he divides the unit of time—a second, for example—into four parts, each of which belongs to a different employé. The operators work so as to obtain the desired result without the different despatches interfering with one another.

TELEGRAPH FOR THE CHINESE.

Mr. S. A. Viguier, of Shanghai, has devised a scheme for the transmission of Chinese messages, which is now used in Shanghai and Hong Kong by the Great Northern Telegraph Company. The Chinese style of writing cannot be transmitted by the ordinary telegraph apparatus, but to give the Chinese an opportunity of sending messages in their own language Mr. Viguier has constructed a system for this purpose. Of the 44,000 words, or thereby, which are found in the Chinese language, only 7,000 occur with any degree of frequency, so that for all ordinary purposes these 7,000 words are amply sufficient. Supposing every educated Chinaman to know at a glance to which of the 214 radicals any character is to be referred, the 7,000 characters are in Mr. Viguier's system arranged in columns under their respective radicals, and every character is, besides, furnished with a number rising from 0001 to 7000. These are printed on seven large sheets bound together, which the Chinese can purchase, and by reference to which they can in a very short time find the characters they want to be transmitted, and writing down the numbers corresponding to these, and using certain conventional signs to distinguish the address, the message, the signature, &c., from each other, the Chinese message can be transmitted as well as any other message. The receiving station is furnished with a board containing 7,000 types, numbered from 0001 to 7000, and having the corresponding Chinese numbers engraved on the other side. When, therefore, a Chinese message has been sent along the wire, the types bearing the number transmitted are taken out, the characters printed on a square ruled form, and the message is ready for delivery. This ingenious invention of Mr. Viguier's is fitted to give a mighty impetus to the use of the telegraph by the Chinese, and will do more to hasten its extended use over the empire than whole reams of despatches. And, however experience and criticism may modify and simplify the notation, it is not to be forgotten that Mr. Viguier was the first to adapt it to Chinese uses.—*San Francisco News Letter*.

IMPORTANT TELEGRAPHY.

At the telegraph office, Washington, on December 11, 1873, an experiment was carried out in the presence of Mr. Cresswell,

the Postmaster-General of the United States, the practical results of which will be of immense importance as regards the future of telegraphy throughout the world. On that occasion the President's last annual Message of 11,500 words was transmitted from Washington to New York, a distance of 290 miles, over a single wire, in 22½ minutes, the speed obtained being over 2,500 letters per minute. At New York the message was delivered from the automatic instrument, printed in bold type, in presence of the Postmaster of New York. Hitherto the speed attainable over circuits of similar length in this country by the Wheatstone automatic system at present in use for the "high-speed" service by the postal telegraph department does not exceed 200 letters per minute.—*Nature.*

GRAMME'S MAGNETO-ELECTRIC MACHINE.

The greatest novelty of its kind is the Magneto-Electric Machine, constructed at the works of Messrs Whieldon and Cooke, and first noticed in *Engineering* of March 14 last. It is the invention of M. Gramme, of Paris, who, it will be remembered, in 1871, produced a machine which gave a continuous induced current. Since then he has introduced several important modifications, which render his invention one of the most remarkable of the age.

We refer the reader to the engravings of the machine, in *Engineering* of March 14, already mentioned; and to the article in the previous page, descriptive of the machine at Westminster Palace.

We subjoin an extract illustrating the effect of the machine. The rotation given to the coils is 350 revolutions per minute. The driving power required is from two and a half to three horse power. The current developed equals that of 525 large-size Bunsen cells.

"The luminous and calorific effects are quite astonishing. A light has been obtained whose brilliancy was nearly equal to that of 1,000 Carcel burners (9,600 sperm candles); and a light equivalent to 900 burners was emitted during a series of experiments extending over several hours. The spectrum afforded by such intense illumination exhibited several interesting features in various lines never before observed. For lighthouse purposes this machine has many advantages over that of the Alliance Company, generally employed. It takes up one-fourth the room, gives twice the light for the same expenditure of power, and for the same light is only half as expensive. Wilde's machine, driven by a fifteen-horse power—the armature making from 1,500 to 2,000 revolutions a minute, a rapidity that gives rise to several inconveniences—achieved a great feat when it fused a platinum bar 2 ft. long and 25 in. in diameter. We have seen the Gramme machine which we have been describing, driven by a three-horse power, the coils rotating at the rate of 350 revolu-

tions per minute, fuse almost instantaneously an 18-guage platinum wire 8 ft. long. A copper wire, 22 ft. long and of 96 per cent. conductivity being stretched between the terminals, was fused in less than two seconds. A piece of a round file ½ in. in diameter and 4 in. long was burnt away in five minutes, and a piece of diamond was volatilised in less than as many seconds. These facts speak more eloquently than all the words we could string together in elucidation of the vast heating energy of this machine.

"But however valuable the apparatus may be by its illuminating power, it is still more so in its applications to electro-chemistry. In this branch it will no doubt be productive of very great results. The high cost of other like machines precludes the possibility of using them with advantage. There is here an extensive and commercially important department, and we are glad to say that it is in the hands of so able a chemist as Mr. Werdermann. We are informed that Mr. Werdermann is devoting much attention to this subject, and he is already cheered in his researches by satisfactory results and equally encouraging anticipations. He expects to produce chemically pure copper at the price of the ordinary commercial; aluminium for about half, potassium and sodium for less than half their current prices; and other metals, such as calcium and magnesium at rates which may bring them into the chemistry of commerce. He expects to purify 2 tons of pig iron in 20 minutes, at a saving of two-thirds the fuel.

"The simplicity of the principle embodied in this magneto-electric machine, as well as the marvellous effects obtained from it, lead us to think that it is destined to play an important part in the development of the various branches of electro-chemistry and metallurgy generally. On the other hand, it is a striking example of the transformation of mechanical into electrical energy. In the steam-engine that drives the coils, we see heat developed into a gigantic motive power; whilst in the machine itself we see this motion instantly converted into a continuous stream of electricity. We are gradually finding our way to a comprehensive and complete dynamic theory, and it is pleasing to notice that the great tendency of modern science is to establish the general correlation and unity of physical forces."—*Engineering.*

ELECTRICAL PHENOMENA OF THE DIONÆA MUSCIPULA.

Dr. Sanderson has read to the Royal Society the following "Note on the Electrical Phenomena which accompany Irritation of the Leaf of *Dionæa muscipula*."

1. When the opposite ends of a living leaf of *Dionæa* are placed on non-polarisable electrodes in metallic connection with each other, and a Thomson's reflecting galvanometer of high resistance is introduced into the circuit thus formed, a deflection is observed which indicates the resistance of a current from the

proximal to the distal end of the leaf. This current I call the *normal leaf-current*. If, instead of the leaf, the leaf-stalk is placed on the electrodes (the leaf remaining united to it) in such a way that the extreme end of the stalk rests on one electrode and a part of the stalk at certain distance from the leaf on the other, a current is indicated which is opposed to that in the leaf. This I call the *stalk-current*. To demonstrate these two currents it is not necessary to expose any cut surface to the electrodes.

2. In a leaf with the petiole attached the strength of the current is determined by the length of the petiole cut off with the leaf, in such a way that the shorter the petiole the greater is the deflection. Thus in a leaf with a petiole an inch long I observed a deflection of 40. I then cut off half, then half the remainder, and so on. After these successive amputations, the deflections were respectively 50, 65, 90, 120. If in this experiment, instead of completely severing the leaf at each time, it is merely all but divided with a sharp knife, the cut surfaces remaining in accurate apposition, the result is exactly the same as if the severance were complete; no further effect is obtained on separating the parts.

3. *Effect of constant current directed through the petiole on the leaf-current.*—If the leaf is placed on the galvanometer electrodes as before, and the petiole introduced into the circuit of a small Daniell, a commutator being interposed, it is found that on directing the battery-current down the petiole (*i.e. from* the leaf), the normal deflection is increased; on directing the current *towards* the leaf, the deflection is diminished.

4. *Negative variation.*—*a.* If, the leaf being so placed on the electrodes that the normal leaf-current is indicated by a deflection *leftwards*, a fly is allowed to creep into it, it is observed that the moment the fly reaches the interior (so as to touch the sensitive hairs on the upper surface of the lamina), the needle swings to the right, the leaf at the same time closing on the fly.

b. The fly having been caught does not remain quiet in the leaf; each time it moves the needle again swings to the right, always coming to rest in a position somewhat farther to the left than before, and then slowly resuming its previous position.

c. The same series of phenomena present themselves if the sensitive hairs of a still expanded leaf are touched with a camel-hair pencil.

d. If the closed leaf is gently pinched with a pair of forceps with cork points, the effect is the same.

e. If the leaf-stalk is placed on the electrodes, as before, with the leaf attached to it, the deflection of the needle due to the stalk-current is *increased* whenever the leaf is irritated in any of the ways above described.

f. If half the lamina is cut off and the remainder placed on the electrodes, and that part of the concave surface at which the sensitive hairs is situated is touched with a camel-hair pencil, the needle swings to the right as before.

g. If, the open leaf having been placed on the galvanometer electrodes as in *a*, one of the concave surfaces is pierced with a pair of pointed platinum electrodes in connection with the opposite ends of the secondary coil of a Du Bois-Reymond's induction apparatus, it is observed that each time that the secondary circuit is closed the needle swings to the right, at once resuming its former position in the same manner as after mechanical irritation. No difference in the effect is observable when the direction of the induced current is reversed. The observation may be repeated any number of times, *but no effect is produced unless an interval of from ten to twenty seconds has elapsed since the preceding irritation.*

h. If the part of the concave surface of the leaf which is nearest the petiole is excited, whether electrically or mechanically, the swing to the right (negative variation) is always preceded by a momentary jerk of the needle to the left, *i.e.* in the direction of the deflection due to the normal leaf-current; if any other part of the concave surface is irritated, this does not take place.

i. Whether the leaf is excited mechanically or electrically, an interval of from a quarter to a third of a second intervenes between the act of irritation and the negative variation.

LECTURE ON ELECTRICITY AT THE CHARTERHOUSE.

AN interesting lecture has been delivered at the Charterhouse by Dr. B. W. Richardson, F.R.S., on "The Original Discoveries in Electricity of Stephen Gray," first Copley Medallist of the Royal Society, who had been a brother of the Charterhouse from 1719 to 1735. A considerable number of guests assembled in the great hall. Stephen Gray first discovered that the electric power could be transmitted along cords or wires, the result being that of electrical action at a distance from the exciting cause. Trying these experiments led him to discover the important principles of conductors and insulators. Induction soon followed, and at the house of Mr. Granville Wheeler he laid what might be called the first electric telegraph, by which, on June 14, 1729, he transmitted electricity along 870 ft. of wire insulated on silk thread stretched across between a series of pairs of poles. In 1731 the result of these experiments was laid before the Royal Society. Gray was soon afterwards admitted a Fellow, and a little later was presented with the Fothergillian gold medal. He continued to experiment in electricity until his death, which occurred on February 15 1735. He predicted that some day the electric spark would be produced so as to resemble lightning, and even went so far as to suggest that lightning was electricity.—*Builder*.

The identity of lightning and electricity was mostly conjecture until, in the year 1750, Dr. Franklin determined the question; and, in 1752, lightning was actually drawn from the clouds by means of a pointed wire, and it was proved to be really the electric fluid.—See *Curiosities of Science*, 1859.

Chemical Science.

EDUCATIONAL CHEMISTRY.

The meeting of the British Association for the Advancement of Science was held at Bradford in September last. At the Brighton meeting the presidentship had been announced to take place under Dr. Joule, of Manchester; but as the day of meeting drew nigh, it became plain that he could not rely upon a measure of physical strength equal to the task before him. The Council then nominated as a successor Dr. Alexander Williamson, the Professor of Chemistry in University College, London, who in his opening Address gracefully alluded to Dr. Joule as "a man whose name is known and honoured in every corner of this planet to which a knowledge of science has penetrated."

Professor Williamson's Address may be said to have had a threefold object: first, to show the meaning of that activity which is now so rife in Chemical Science; secondly, to advocate the use of Chemistry as an engine of Education; and, thirdly, to suggest means of promoting the Advancement of Science. We have not space to particularise the details of the above heads—interesting though may be the historical summary sketched in the *Athenæum* report—but must be content to quote how Professor Williamson brings us up to the modern idea of "Atomicity." He shows that a family relationship exists between different atoms; that they may, indeed, be grouped together in several classes, according to their combining power. If one atom of an element or radical combines with one atom of another element or radical, the chemist calls it a *monad*; if with two atoms a *dyad*; with three, a *triad*; with four, a *tetrad*; with five, a *pentad*; and so on. The discovery of this principle, by which atoms admit of being arranged in groups according to their capacity for combination, is regarded by Professor Williamson as "one of the most important additions ever made to our knowledge of these little masses."

Atoms arrange themselves in little heaps, called *molecules*, or atom-clusters. The modern chemist has managed to get a curious insight into the molecular structure of many of his compounds, and is thus led to explain the difficult subject of *isomerism*. Two bodies are isomeric when their molecules contain atoms of like kinds in equal numbers; ether and butylic alcohol were cited by the President as examples. A molecule may be made up of a certain number of atoms; and, without changing either their number or their character, other molecules of a very different kind may be formed, solely by varying the arrangement of the atoms; grouped in one fashion they may form ether, in another butylic alcohol.

We need hardly follow Professor Williamson in his further discussion of the properties of atoms, and on the development of his original views on the activity of the atoms of a molecule. What he has to say about atoms he brings to a conclusion by defending the Atomic Theory against the attacks of certain modern chemists. Professor Williamson asked at the outset, what is the meaning of the great activity in modern chemistry? And he is able to reply, "Chemists are examining the combining properties of atoms, and getting clear ideas of the constitution of matter."

Next, in his inquires into the use of Chemical Research, he pointed out the value of chemical pursuits in developing some of the most useful habits and noblest qualities in our nature.

Looking to the mental training which the student of Practical Chemistry receives, Professor Williamson believes that this science presents peculiar advantages for the purposes of education; in fact, that it is, at present, unrivalled in this respect. There is no doubt that when chemistry is properly taught—taught as Professor Williamson treats it—it becomes an instrument of no mean power. Everbody in the land ought to know something about the elements of chemistry. Moreover, chemistry forms an excellent starting-point for a course of scientific training, connected as it so intimately is with almost every other branch of science.

The peculiar advantages which chemistry offers as a means of intellectual culture have rarely been so clearly set forth as by Professor Williamson. "There is reason to believe," says he, "that it will play an important part in general education, and render valuable services to it, in conjunction with other scientific and literary studies." Nor is chemistry without its use in developing and training the imagination. Indeed, modern chemists, with their "graphic formulæ," have, perhaps, erred in too freely exercising the imaginative part of their nature.

Admitting, then, that scientific work—for chemistry has been taken only as a type of scientific work in general—has so large an area of usefulness. it behoves us to inquire how scientific training may be efficiently promoted, and the ends of a scientific education best served. The British Association is professedly formed "for the Advancement of Science." It is therefore only right that measures tending to benefit the cause of science should emanate for this body; and Professor Williamson has taken excellent advantage of his position to put forward a scheme by which scientific research may be developed and extended. His first effort is to train his men of science, and his next to place them under proper conditions for making them active and useful to others.

In advocating a national system of scientific education, Professor Williamson could not have chosen a better opportunity than that afforded by the present meeting. Every one in Bradford must be proud of the part which their member has played

in promoting the cause of popular education, and in enabling us to realise to-day the aspirations of Wordsworth:

> O for the coming of that glorious time
> When, prizing knowledge as her noblest wealth
> And best protection, this imperial Realm,
> While she exacts allegiance, shall admit
> An obligation, on her part, to *teach*
> Them who are born to serve her and obey;
> Binding herself by statute to secure
> For all the children whom her soil maintains
> The rudiments of letters.

But Professor Williamson would urge the action of the State beyond that of teaching merely "the rudiments of letters." He pleads for nothing less than the support of a complete system of scientific instruction. Not that he asks the Government to found new scientific institutions; but he seeks support for those already in existence. Educational grants should be limited, he maintains, to those institutions which show, by their work, that they are worthy of such support—those which, when tested by official inspectors, prove their usefulness and vitality.

We have sketched this outline from a paper in the *Athenæum* upon Professor Williamson's inaugural address: a remarkable production of its class, and characterised by the simplicity and comprehensiveness of its teachings.

ALIZARINE.

THE ordinary course pursued by past Presidents of the Chemical Section has been, in the opening address, to give a sketch of the history of Chemical Progress during the past twelve months; but in the past year Dr. Russell has deviated from precedent, and has limited his remarks to one particular illustration. Dr. Russell could not have had a better subject than the history of Alizarine—the artificial production of the colouring matter found in madder.

The value of the madder plant as a dyeing material has been known for ages, and the plant has consequently been cultivated wherever it would grow with success. India, France, Italy, Holland, South Germany, and Turkey, are the portions of the globe from which the supply for the English market is obtained; and it appears that about one-half of the entire quantity grown is used in the United Kingdom, this quantity having, a few years ago, the estimated value of 1,284,989*l*. The attempt to grow the madder plant in England has usually failed, and, where successful, has proved unprofitable, from the much larger amount of land being required to produce the same quantity than is necessary elsewhere. These facts give great importance to the introduction of an artificial substitute. The colouring matter which is obtainable from the madder and its allied plants is

valued especially for the ease with which calico and cotton fabrics can be dyed with it. Nearly all the pink, purple, and black colours seen on printed calicoes are obtained by its use; and, as the newly-discovered aniline dyes are more adapted for colouring silk and wool, the madder dye has, up to the present time, not been superseded, but has been gradually increasing in value. Now, however, this is likely to be changed, as the artificial production of the substance is steadily gaining ground; the colouring matter itself has received the name "Alizarine." This substance, however, curiously enough, does not exist in the plant as such, but is the product of a partial decomposition. A substance named Rubianic Acid, or, as Dr. Russell calls it, Rubian, is found in the madder root, and this, on keeping, or treatment with hot water, splits up into Alizarine and glucose. This Alizarine has been examined carefully by several chemists, and its constitution had been pretty nearly made out some time before a thought of its artificial preparation had occurerd. Two things are exceedingly striking in the history of this artificial colouring-matter, as set forth in the address: the one is, the very great value which the atomic theory has to chemists, especially when building up new compounds, or endeavouring to recognize the relation which one group of compounds bears to another group; and the other, the great results which often accrue from this building up or synthetical mode of working. Without the help and guidance of the atomic theory, certainly no connexion would have been discovered between Alizarine and Anthracene, the hydro-carbon contained in coal-tar, and now the source of all the artificial product.

In his address Dr. Russell sketched very succinctly the different stages by which this analogy was proved, and its perusal must set many thinking whether it is not quite possible to build up other and still more complicated bodies, which until now have been recognized as solely the product of animal and vegetable life. The names of Schunck, Strecker, Kekulké, Graebe, and Liebermann, as the investigators most nearly connected with the history of this substance, Alizarine, suggest to us that the German chemists are in advance of their English *confrères* in this work. Great credit is, however, due to our countryman, Mr. Perkin, for rendering the production of the artificial Alizarine profitable. Graebe and Liebermann had certainly produced from anthracene a substance identical in every way with the natural Alizarine, but this was only accomplished by the use of a costly re-agent, bromine; and if this had proved the only method of production, artificial Alizarine would have remained simply a chemical curiosity. Mr. Perkin, however, was able to dispense with bromine, and to use one of the cheapest and most abundant of chemical re-agents, sulphuric acid; and thus the discoverer of aniline violet or mauve added to his other triumphs that of being the man to place in the hands of the manufacturer an abundance of a dye that had hitherto been ex-

pensive on account of its sparse cultivation. Dr. Russell paid a well-deserved compliment to Mr. Perkin for the energy and ability which he has displayed in the investigation of these artificial colouring matters. The success attending the introduction of this artificial product is complete, and the quantity of natural madder imported is daily getting less, and its value is also decreasing rapidly. The study of colouring matters was formerly placed outside the limit of the chemist's investigation; but the reward in more than one direction which has followed patient working on these substances will go far to stimulate research upon them, and, as Dr. Russell well remarks, "Now the chemist can compete with Nature in its production, which colouring matter will follow next it is impossible to say; but sooner or later that most interesting one, scientifically and practically, indigo, will have to yield to the scientific chemist the history of its production."

The source from which most of these new colouring matters are obtained is somewhat surprising, but, when considered, certainly very satisfactory. Ever since the manufacture of illuminating gas from coal began, the manufacturer has always found himself possessed of a number of by-products of a more or less wasteful nature. The value of some of these has been gradually appreciated, but others have had to be disposed of at a considerable sacrifice. Since, however, the discovery that from benzol all the aniline colours could be obtained, the value of that body has immensely increased, and, as the greater bulk of it is obtained from the tar of the gasworks, the sale of that substance has become profitable; and now, as the demand for artificial Alizarine increases, the value of its parent, hydro-carbon anthracene, also contained in the tar to the extent of about one per cent., will likewise increase. Nothing can give more satisfaction to the chemist than the doing away with what are called waste products, and every step in this direction is a matter for congratulation.

Dr. Russell's address will be very acceptable to those who like to see sound practical results grow out of the chemist's researches, while among chemists themselves it cannot but be recognized as strong evidence in favour of theoretical chemistry. Dr. Russell supplies also an apt illustration to some of the remarks in the President's inaugural address. (*See* p. 142.)

NITROUS OXIDE GAS.

MISS IDA WYNDHAM, a lady who had resided at the Manor-house, Seaton, died lately while under the influence of Nitrous Oxide Gas administered to her by Mr. J. T. Browne Mason, a dentist practising at Exeter. It appears that, accompanied by Dr. Pattinson, her medical attendant and brother-in-law, deceased went to Mr. Mason's to have her teeth examined. Mr. Mason advised her to have a large upper tooth drawn, and

at her urgent request administered the Nitrous Oxide Gas, which has been adopted by many dentists instead of chloroform Dr. Pattinson remained while the operation was being performed After a few respirations it was noticed that the pulse was becoming rather weak, and the inhalation was stopped The patient had not become insensible, however Mr Mason endeavoured to extract the tooth but the pain was so great that he was obliged (and again at Miss Wyndham's desire) to administer the gas a second time The operation appeared to be perfectly successful and the tooth had been drawn, when suddenly the patient's features became livid, and it was at once apparent that something was wrong The assistance of Dr Drake was immediately procured, and everything was done to restore consciousness, but without result, and in the course of a few minutes the patient died The evidence of Dr Pattinson showed that up to the day of her death Miss Wyndham had enjoyed excellent health, and Dr Drake agreed with him that neither before nor after death were any symptoms of organic disease observable Dr Drake attributed death to paralysis of the respiratory organs, caused by the inhalation of Nitrous Oxide Gas Both medical men were of opinion that every precaution was used by Mr Mason and Dr Drake said there was nothing to indicate that Miss Wyndham was not a proper subject for an anæsthetic The jury returned a verdict of "Homicide by Misadventure," and fully exonerated the dentist from blame —*Times*

COMPOSITION OF THE COINAGE

DR. ODLING, President of the Chemical Society, read a paper "On the Preparation of Standard Trial Plates to be used in Verifying the Composition of the Coinage." After giving a sketch of the variation in composition of the English gold and silver coins from the earliest times, he noticed the various trial plates which had been prepared since 1660, showing that they sometimes varied considerably from the standard of 916·66 parts in 1,000 for the gold, and 925·0 for the silver. He then proceeded to describe the process employed, and the difficulties to be overcome in the preparation of the new standard trial plates. These were exhibited, and also a magnificent specimen of pure crystallised gold.

NEW BLUE DYE.

HOFFMAN has lately prepared a new Blue Dye from azo-diphenly-diamine by heating equal weights of the pure azo-base and of hydrochlorate of aniline to 160 degrees C. for four or five hours with a double weight of alcohol in a sealed tube. A pasty blue dye is formed, but it is not equal to the analine blues.—*J. C. Bourne, Illustrated London News.*

CHEMISTRY OF BONE.

SOME valuable contributions to the Chemistry of Bone, by Messrs. Maly and Donath, have been laid before the Academy of Sciences of Vienna, and are reproduced in the *Journal für praktische Chemie*. The authors conclude that the phosphate of lime exists merely in a state of intimate mechanical association with the organic matter, and not in the form of a chemical combination.

TRANSFORMATION IN YEAST.

M. PASTEUR has read before the Académie des Sciences a note in reply to M. Trécul concerning the transformation of the spores of *Penicillium glaucum* in yeast, which was the subject of a communication from M. A. Trécul on December 8. M. Pasteur states that he has repeated the experiments, taking the necessary precautions, and that the transformation has not been produced.

STUDIES ON BEER.

M. L. PASTEUR has explained to the French Academy a new method of brewing it and rendering it unchangeable. The author considers the spoiling and souring of beer to be due to germs, and suggests methods for preventing their access or destroying them during the processes of brewing.

CITRATE OF MAGNESIA.

MR. JOHN MUTER, public analyst for Southwark, contradicts the statement made in a letter to the *Times* that true Citrate of Magnesia is insoluble in water. He can at his laboratory demonstrate to anyone holding this opinion the absurdity of his views by making true citrate of magnesia in his presence, or by showing him a sample which he can obtain through the Messrs. Howard. He says the true citrate of magnesia is used in France, and in commenting on it the *Journal de Pharmacie* says: "Ce citrate est soluble dans l'eau." He complains that the post of public analyst to a number of districts is sufficiently onerous without the holder being continually obliged to defend himself from attacks based on palpable chemical errors. He adds that everyone interested either in trade misrepresentations and adulterations, or disappointed in obtaining public analytical appointments, seems to consider the public analyst fair game both for attack in the newspapers, or through vestrymen, who are sometimes induced to act on mistaken premises, or by anonymous threatening letters. In conclusion, he says that he has himself been subjected to such annoyances, but in his case the attacks fall harmless, as he feels confident that the public will support those who are endeavouring to do their duty by carrying out the provisions of an Act unfortunately hedged round with legal difficulties.

SUNLIGHT FOR THE SICK.

Dr. William H. Hammond, in discussing the Sanitary Influence of Light, observes that the effects of deficient light upon the inmates of hospital wards and sick chambers have frequently come under his personal observation. Most physicians know how carefully the attendants upon the sick endeavour to exclude every ray of light from the apartment; and it must be admitted that the members of the profession are often fully as assiduous in this respect. That the practice, except in some cases of actual disorder of the brain and other parts of the nervous system, is pernicious, he is well satisfied. During the early years of the late war he visited the camp and hospital of the regiment stationed in West Virginia. Reports had reached General Rosencrans' headquarters that the sickness and mortality were something frightful, and he was ordered to examine minutely into all the circumstances connected with the situation of the camp, the food of the men, &c. Among other things he found the sick crowded into a small room, from which the light was excluded by blinds of indiarubber cloth. They were as effectually bleached as is celery by the earth being heaped up around it. Pale, bloodless, ghost-like looking forms, they seemed to be scarcely mortal. Convalescence under such circumstances was almost impossible, and doubtless many had died who, had they been subjected to the operation of the simplest laws of nature, would have recovered.—*British Medical Journal.*

PEPSIN IN OYSTERS.

It appears from some experiments made by Mr. E. H. Haskins (*Boston Medical and Surgical Journal*), that raw Oysters contain pepsin enough to digest themselves. No wonder oysters agree with most dyspeptics.—*London Medical Record.*

PASSAGE OF GASES THROUGH THE TISSUES OF PLANTS.

M. M. A. Barthélemy has been making some very interesting experiments "On the Passage of Gases through the Membranaceous Tissues of Plants." The leaves of certain varieties of the Begoniaceæ, which are thin on the living plant, are reduced during winter to the condition of a pellicle indued with elasticity. Those were employed as colloid membranes, and Graham's experiments were repeated, and compared with the films of caoutchouc by M. Barthélemy. These experiments prove the dialysis of carbonic acid by the living plant through the cuticle of leaves, in a manner precisely similar to the endosmose of membranes, or of porous vessels, in the experiments of Dutrochet and Dehérain. The details will be found in the *Comptes Rendus*, No. 77. —*Athenæum.*

ARSENIC IN THE HOUSEHOLD.

An arsenical odour having occasionally been observed during the burning of green wax tapers or similar articles, Mr. T. Bolas, of Charing-cross Hospital, was induced to examine several samples of green tapers, Christmas candles, and so forth, with the view of ascertaining what colouring matters were used in their manufacture. Of thirteen samples one only contained arsenic, the majority being coloured with verdigris, and two samples were tinted with ultramarine green. The arsenical tapers were of the kind usually employed in houses for lighting gas, and one taper, weighing 17·69 grains, was found to contain 0·276 grain of arsenious acid. Now, considering the extreme sensitiveness of some people with regard to arsenic, especially when this poison enters the system by the respiratory organs, it will be obvious to all that it is highly improper to use a volatile poison like arsenic, even though the quantity employed is small, for colouring tapers or other similar articles intended for burning in houses. The case of a Christmas-tree brilliantly illuminated with arsenical candles may be taken as an extreme instance of the danger likely to arise from this source. A short time previously Mr. Bolas had occasion to examine a sample of wall-paper containing 27·53 grains of arsenious acid in a square foot, and in this case the poison was so loosely fixed that a very slight attrition sufficed to detach a portion and diffuse it through the air as a fine dust. —*Lancet.*

PROMPT REMEDIES FOR ACCIDENTS AND POISONS.

We have received a copy of a very useful chart, prepared by Mr. W. H. Hyett, F.R.S., and containing plain directions what to do in cases of poisoning, drowning, accident, and the like, until medical aid arrives. Charts of a similar description have been previously constructed, and some of them are highly valuable; but that of Mr. Hyett differs from all others in being entirely divested of technicalities, so that it is intelligible to any person who can read and understand common words. The author suggests that his chart should be pasted on cardboard, and hung up conspicuously and loosely, ready to send out in a moment, in country school's or vestries, dock or railway offices, factories and private houses; and he says that its first object is to prevent the frequent, and perhaps fatal, mistakes into which, before the arrival of a doctor, the inexperienced are apt to fall; and that its second object, in cases where life may depend on an immediate remedy, is to point out such as are most usually at hand. The emergencies enumerated include hanging, drowning, still-birth, suffocation from foul air, lightning-stroke, injury from intense cold, sunstroke, choking, bleeding at the nose, broken bones, severe wounds, burns and scalds, &c., and the effects of almost all common poisons—among which carbolic acid, which

has lately proved fatal to several persons, receives full notice. The directions given are throughout sound and trustworthy, and are calculated to render good service on the occasions to which they refer. The chart is published by Trübner and 'Co., and is sold for the benefit of the Gloucestershire Eye Institution.

A SUBSTITUTE FOR QUININE IN AFRICA.

A correspondent of the *Times* having attended to the mangrove-tree as an indicator of the presence of disease mortal to the European, relates this experiment on the properties of the above tree:—

"Years ago, a friend of mine was detained on duty at a dreary out-station of Sierra Leone. He had doubtless heard and recollected that the juice of the tree was an antidote employed by the native doctors of India in the counteraction of the bite of venomous snakes; and biassed thus by a certain vein of thought, he could not perhaps well understand why the juice, proved to be therapeutic in one direction, should not also be converted to some good purpose in Africa. After submitting to much trouble, and after meeting with numerous failures, he discovered that by boiling the bark of the tree he got a decoction which he fancied supplied the place of quinine. At any rate his tests went so far as to demonstrate this, that all the men—for he had a few troops under his charge—to whom he gave the liquor remained free from fever, but that those to whom he did not give any of it were sufferers in the usual way.

"If my memory fail me not, he gathered the bark at that season of the year when the tree was about to bud or to put forth fresh shoots—when, in truth, the sap was rising; but he was removed from the station and ordered to England before he had quite satisfied himself that he had added a new light to the brilliant firmament of medical science.

"It is possible that the hint curtly thrown out here may be useful to a sharp member of the staff under Sir Garnet Wolseley, and may provoke an opportunity of maturing an idea which had only begun to germinate.

"I remember well that we were wont to talk over the chances of laying the foundation of a decent fortune by bringing a fresh commodity into the market not unlikely to supersede the expensive alkali, quinine; and I went the length of begging an officer quartered at Bathurst—now dead and buried there, poor fellow—to send me home a boxful of the bark cut off the mangrove-trees which infest the Gambia river. My friend, however, is dead, and I am no nearer a grand commercial achievement than what is identified with the prospects of (as he signs himself) a Director of the African Barter Company."

VULCANISED INDIARUBBER.

At a meeting of Civil Engineers at Aachen, Herr Hasenclever, of the chemical works, Rhenania, at Stolberg, communicated the results of analyses which were made on vulcanised indiarubber, pipes and other materials intended to be used at these works. They contained invariably from 40 to 50 per cent. of foreign mineral substances. The ordinary test for good indiarubber, that it has a specific gravity of 0·985, and swims upon water, no longer holds good, as frequently cork and fine sawdust is mixed up with it, and owing to the deterioriation of indiarubber articles their technical use seems far more restricted than should be supposed. Good quality being the first requirement for technical use, the price should be a secondary consideration; however, rubber of an inferior quality may be usefully employed as packing rings in steam pipes, when the admixed mineral substance will have little influence. The discovery that indiarubber, when heated, will combine with sulphur, was made by Professor Lüdersdorf, of Berlin, 40 years ago, but was practically utilised by Mr. Goodyear for indiarubber shoes in England and America. The vulcanising process differs much in the quantity of sulphur employed, and the heat and length of time to which the products are exposed in the vulcanising chamber, and many features of the process are not yet clearly known, such as violent explosions. The vulcanised indiarubber is coloured by means of various substances—red by an admixture of antimony; black, by pine soot; white, by white lead or sulphate of barytes, which is also used to increase its weight. The influence of the sunlight and the air, which will harden the indiarubber when it is exposed to them for a long time, is well known, but not yet sufficiently explained.—*Engineering.*

NEW CHLORINE PROCESS.

A new process has been invented for the production of Chlorine by passing muriactic-acid gas through a furnace, with certain suitable adjuncts. M. Ressie du Mothay also effects the same object by passing muriatic acid gas through a retort containing black oxide of maganese heated to redness, when a decomposition takes place into chlorine gas and watery vapour. The manganese is afterwards recovered by passing over it a stream of air, and it may thus be used over and over again. The process is rather a complex one; but none of the substances acted upon are wasted, but are in every case recovered and made available for future use.

GASES IN ARTERIAL BLOOD.

"Des Gaz du Sang" is the title of an elaborate memoir, contributed jointly by Dr. Mathieu and M. V. Urbain to the current number of the *Annales de Chimie et de Physique.* The

authors describe in detail their experiments on the various conditions which effect the proportion of gases dissolved in arterial blood, a similar question, with respect to venous blood, having been previously discussed by M. C. Bernard. The principal points to which attention is directed in the present memoir are effects of repeated bleeding on the gaseous contents of the blood; the differences in the blood-gases, according as the fluid is drawn from this artery or that; and the influence of external temperature and atmospheric pressure on the character and quantity of the gases held in solution in the blood.—*Athenæum.*

TRANSPARENT PAPER.

The *Journal of Applied Science* informs us of a German invention for the above. Good writing-paper, saturated with benzine, and then coated with a rapidly-drying varnish, prepared of boiled bleached linseed oil, 20 lb.; lead shavings, 1 lb. oxide of zinc, 5 lb.; and Venetian turpentine, ½ lb. These are mixed and boiled for eight hours. After cooling and straining, 5 lb. of white gum copal and ½ lb. of gum sandarac are added.

OPIUM-SMOKING IN NEW YORK.

The opium-smoker always lies down when indulging his habit, and gives all his attention to the process of inhaling the fumes of the drug. Before opium can be use by the smoker it has to be prepared most carefully by persons skilled in its concoction. It is reduced from a solid to a liquid form by boiling with a small quantity of water, and when ready for the pipe looks like a thin paste or thick, muddy mollasses. The opium pipe consists of a reed about an inch in diameter. The aperture in the bowl which admits the drug is not much larger than the head of a pin. One-hundredth part of an ounce is all that can be smoked by a beginner. Old *débauchés*, however, can use from a quarter to a third of an ounce daily. An old opium-smoker invariably blows the fumes through his nostrils, and very often absorbs them in his lungs. The opium pipe must be lit with great care, and always by the steady flame of an oil lamp. The small opening in the the bowl is held in the flame, and the light is drawn into the reed. After the opium is ignited, the process of smoking is very short; only one or two whiffs can be taken, and in this way, lighting and smoking, scores of persons, inhabitants of the city, spend hour after hour, never ceasing until they drop off into the death-like stupour which is the aim of all opium-smoking. Those persons who become addicted to the use of the poison seldom live to be more than 50 years of age; most of them die within five years after they have reached that stage in which they can consume a third of an ounce a day.

Natural History.

ZOOLOGY.

Professor Allman has read to the British Association the introductory address of the Section—a general review of the present aims and objects of Biological Science. It was a curious proof of the way in which new ideas filter down into the community, and become accepted as it were by a kind of acclimatization, to hear the doctrine of evolution poetically expounded and applauded, as the speaker with an earnest eloquence, which had a peculiar kind of fascination about it, showed how this doctrine brought into a rational convergence all the hitherto scattered lines of biological investigation. It implies a considerable change in popular opinion, that the acceptance of the doctrine of descent should seem to require no sort of defence, and, in fact, that not much should need to be said in its support; but there was a tone of such gentle persuasion from the opening of the address to its close, and the difficulties that still stand in the way of accepting the validity of the evolution hypothesis to the fullest extent were so dispassionately treated, that the antagonism of even a cruder state of popular feeling could hardly have failed to be disarmed. On the one hand, evolution was the highest expression of the fundamental principles established by Mr. Darwin, and depended on the two admitted faculties of living beings—hereditary, or the transmission of characters from parents to offspring, and adaptivity, or the capacity of having those peculiarities modified in the offspring. On the other hand, the continuity of organic forms had in few cases been made out so successfully as it had been by Professor Huxley in the case of the horse. Then, again, the first appearance in the earth's crust of the various classes presented itself in forms which by no means belonged to the lowest or most generalized of their living representatives. Finally, while the recapitulation of ancestral forms had much probability, and harmonized with the other aspects of the evolution doctrine into a beautifully symmetrical system, it was one for which a sufficient number of actually observed facts had not yet been adduced to remove it altogether from the region of hypothesis. The suggestion which was thrown out at the end of the address, that life has had more than one starting-point upon the earth, and has flowed down, in several streams, here and again becoming extinguished; and the belief in spontaneous generation might obviously found on the hypothesis that there had been many points at which life had started upon the earth, that Professor Allman expressed his conviction that no valid evidence had yet been adduced to lead to

the belief that inorganic matter had become transformed into living. otherwise than through the agency of a pre-existing organism. It might be, however, that physical forces, manifesting themselves through the organisable protoplasm, become converted into the phenomena of life, and that the poet had unconsciously enunciated a great scientific truth when he spoke of—

> Gay lizards glittering on the walls
> Of ruined shrines, busy and bright,
> As though they were alive with light.

Professor Newton read the Report of the Close-time Committee, which was very unfavourable to recent legislation. Small birds appear to require no protection, while on the other hand it was urgently needed in the eyes of the naturalist for the rarer wild fowl, the numbers of which are in many places, owing to inevitable causes, very much reduced, and which must consequently without protection in many localities speedily become extinct. A lively discussion followed, in which, amongst other speakers, Miss Lydia Becker rather quaintly lamented the impossibility of getting reasonable attention from the Legislature for the wrongs of small birds, women, and poor children. Mr. Lankester then read the Report on Zoological Stations. Photographs of the handsome building which Dr. Dohrn had succeeded in erecting in the grounds of the Ville Reale at Naples were shown, and a list was given of the various Governments and Universities, including that of Cambridge, which had supported Dr. Dohrn by renting tables in the laboratory which forms part of the station for the use of their students. The munificence of an American capitalist, in supplying Agassiz with the means of founding a similar establishment at Buzzard Bay, was also made by many speakers the text of the suggestion that English capitalists in our great manufacturing towns might perhaps do something equally useful for natural science in England.

Professor Balfour read the Report of the Committee for observing the Effect of the Denudation of Forests on the Rainfall of Scotland. The opinion was pretty generally expressed that the observations which the Committee proposed to undertake were over far too limited an area to give any result. The remainder of the meeting was occupied by a paper 'On the Flora of Bradford,' which gave an interesting account of the vegetative physiognomy of the neighbourhood. Next was read Mr. Blandford's interesting paper 'On the Fauna of Persia.' The animals of this country belong mainly to the desert type, with an infusion of Indian forms in the south, and of European to the north. It is remarkable, however, that, while the lion in Persia is only found in the southern portion, the tiger is confined to the forests of the shores of the Caspian. Local papers on the Birds and Mosses of the West Riding occupied the attention of the section for some time. One of the advantages of the visits of the British Association to different parts of the country is undoubtedly to

bring the local naturalists into contact with those who have made themselves authorities in different branches of natural history.

The concluding paper was one of an interesting character. Mr. Lankester had noticed the occurrence of a peach-coloured film in a neglected jar, containing fluid, in his laboratory. It proved to be produced by one of the problematical organisms known as Bactoria. These include a number of very different forms, which have been described as distinct from one another. Mr. Lankester found examples of nearly all of these in the fluid he examined; and he inferred with great probability, from the uniformity of their colouring, that they were all phases in the life-history of one species. This constitutes a great step in our knowledge of these obscure but, physiologically speaking, exceedingly important organisms.

WILD BEASTS IN INDIA.

THE number of persons destroyed by wild beasts forms an extraordinary feature of Indian life. Rewards are offered by the Government for the killing of these animals, but still the loss of life is very great in some districts, and in others it is less only because goats are abundant, and the wolves prefer kids when they can get them. No less than 14,529 persons lost their lives by snake bites in 1869, and in 1871 there were 18,078 deaths reported as caused by dangerous animals of all classes; but Dr. Fayrer is of opinion that systematic returns would show that there are more than 20,000 deaths annually from snake bites. The inhabitants of the border lands between jungle and cultivation are killed and eaten by tigers in such numbers as to require the serious attention of the Government. A single tigress caused the destruction of 13 villages, and 256 square miles of country were thrown out of cultivation. Another tigress killed 127 people in 1869, and stopped a public road for many weeks. A third killed 108 people in the three years 1867–69. In Lower Bengal alone 13,401 human beings were killed by wild beasts in six years, and 40 in South Canara in the single month of July 1867. The Chief Commissioner of the Central Provinces has to report 946 persons killed by tigers in three years ending with 1869. There are difficulties in the way of extirpating tigers; the natives regard the man-eating tiger as a kind of incarnate and spiteful divinity whom it is dangerous to offend, and it is the desire of a few in India actually to preserve tigers for sport. Mr. Frank Buckland has suggested an organised destruction of the tiger cubs in the breeding season, and the attraction of full-grown tigers to traps by means of valerian, of which tigers (which are only gigantic cats) are exceedingly fond. —*Times.*

A RACE OF DWARFS.

The Geographical Society of Italy has received from Alexandria, with the news of the death of the explorer Miani, and various ethnological objects, two living individuals whom he had forwarded of the tribes of the Akka or Tikku-Tikki, and whom the learned traveller had bought of the King Munza. These individuals—of whom one is 18 years old and 40 inches in height, and the other 16 and 31 inches high—are stated by Miani to belong to the race of dwarfs described by Herodotus, and recently re-discovered by the German explorer Schweinfurth, who described them carefully. They are pot-bellied, very thin-limbed, and knock-kneed, spherical and prognathous crania, very long limbs, copper skins, and crisp, tow-like hair.—*London Medical Record.*

SQUALUS SPINOSUS.

On October 9 the fishermen of Durgan, in Helford Harbour, observed a fish new to them, which had been caught (with a ½*d.* hook) on the preceding night near its entrance. Congers had been numerous, but suddenly ceased to bite. The fish (a spinous shark) had been hooked in the corner of its mouth, out of the reach of its sharp teeth and had wound the line may times round its body, which was 7 ft. in length, and 30 in. in girth, being longer and more slender than one sent to the Royal Cornwall Institution 38 years ago. The back, sprinkled over with spines, was of a dark grey colour, the belly nearly white. The lobes of the liver were 4 ft. in length. In the stomach was a partially digested dogfish, 2 ft. long. The upper lobe of the tail was muscular and long, perhaps to aid its ground feeding; the lower lobe more marked than in Dr. A. Smith's drawing, as given by Yarrell, and entirely unlike that of the Filey Bay specimen. Twelve hours or more after its capture, when all external signs of life had disappeared, the writer was surprised to observe the regular pulsations of the heart.

Prof. Huxley has not observed a correspondence between the mass and large convolutions of the brain of a porpoise and its intellectual power.

"Several years ago," says the writer, a herd of porpoises was scattered by a net, which he had got made to enclose some of them. It was strong enough to catch tigers if set in the Straits of Singapore, across which they sometimes swim. The whole "sculle" was much alarmed; two were secured.—*Nature.*

FORMATION OF EGGS.

Mr. Ray Lankester, at the meeting of the British Association, discussed some interesting points as to the nature and mode of formation of eggs, in connexion with his observa-

tions on the egg of the cuttle-fish, *Loligo*. Every egg is originally a small corpuscle of protoplasm, like those which build up the tissues of animals; but it acquires additional substance, and, in some animals, for instance birds, becomes very large before it is laid. The additional substance differs in its character in different animals. In *Apus* four original egg-corpuscles fuse and form one egg—from which one embryo developes. In most cases the egg grows in the ovary by receiving nutrition from the blood. But in many cases—in birds, fishes, and in cuttle-fish—the egg is contained in a capsule, which is lined with living corpuscles; and these are continually multiplying by division, and pass from the capsule into the egg to increase its bulk. This Mr. Lankester had demonstrated by sections in the case of *Loligo*. So far he agreed with Professor His; but he did *not* find that these corpuscles remained alive and helped to form the embryo cuttle-fish. The egg of *Loligo*, when laid, was a perfectly homogeneous mixture of albuminous matters—of *a*, the original egg-corpuscle; *b*, the corpuscles from the capsule; and *c*, the male spermatozoa. From this mixture there segregated at first to one pole plastic matter, which broke up into corpuscles forming a cap (yolk-cleavage). Outside this cap of cleavage-corpuscles other large corpuscles then made their appearance by a new and independent process of segregation (free cell-formation); and these became branched, forming a deep or middle layer in the embryo, whilst the cleavage-corpuscles spread over them at a higher level. Dr. Anton Dohrn and Dr. Carpenter made some remarks on this subject, the latter gentleman taking the opportunity to describe his own observations on the egg-capsules of the dog-whelk made twenty-five years ago, which he seemed to think were not well known, and had a bearing on the present subject. Mr. Lankester explained that he had studied the eggs both of the dog-whelk and of other Gasteropods; that he did not agree with Dr. Carpenter's view of that matter, and that it had no relation to the mode of growth and development of the egg of the cuttle-fish.—*Athenæum*.

THE TEETH.

Dr. Sillin has lately published a compact little volume on "The Teeth in Infancy and Age," in which we find this popular explanation of toothache:—

"The commonest, or acute, toothache is induced thus: in the centre of every tooth is a cavity corresponding in shape to that of the tooth itself, and into this cavity passes through a minute aperture at the end of each root, a branch of a nerve, an artery, and a vein; when, either by mechanical injury or decay, this cavity becomes exposed to the air's action, the blood thickens or coagulates to an extent beyond the capacity of the vein to remove in the natural way; inflammation ensues and pain commences, at first slightly; more blood is pumped in at every pulse

of the heart, through the branch of the artery, and the hard material of which the tooth is formed being unyielding, a pressure is set up on the walls of the cavity and its contents, including the nerve. This pressure is increased at every pulse with the greatest precision, causing intense and hourly-increasing pain. This is what is known as acute toothache. Another very common but less painful kind of toothache is that arising from inflammation of the root and the socket in which the tooth is situated. This disease generally commences with a feeling of the affected tooth being somewhat longer than its fellows, causing more or less pain on closing the jaws. Great pain is sometimes caused by a particle of food, or even by the tongue pressing against it, the contact of hot or cold water causing the sufferer to start with a paroxysm of intense pain. After a considerable duration of suffering suppuration commences, a boil is formed on the gum covering the roots, which in a short time bursts, the pain gradually subsides, and the patient congratulates himself on being rid of his enemy. This is, however, a great mistake. A fistulous opening remains, through which on every apposition of the teeth. or on the pressure of food, a small quantity of pus is forced into the mouth and consequently swallowed, causing the breath to become intolerably offensive (a condition generally unknown to the sufferer), and originating numerous constitutional disarrangements and complications."

BIRDS AND THEIR FOOD.

Some interesting information relating to the ravages of insects was given by Mr. C. O. Groom Napier to the House of Commons Committee of last session, on the protection of wild birds. In 1872 the caterpillars of the brown-tail moth were so numerous as to defoliate the trees of a very large part of the south of England. The alarm was so great that public prayers were offered in the churches that the calamity might be stayed. The poor were paid 1s. per bushel for collecting caterpillars' webs, to be burnt under the inspection of the overseers of the parish; and fourscore bushels were collected daily in some parishes. The brown-tail moth is a beautiful little white insect, about an inch in expanse of wings. Mr. Napier noticed that in 1853 it defoliated about 20ft. of a hedge near Parkstone, Poole; and in 1855 the caterpillars riddled and deprived of their leaves two plum trees in his garden at Lewes, one of which died. The caterpillar of the gamma moth is one of the most injurious to garden plants; it principally feeds at night, and, concealing itself by day, is unperceived. The gamma moth overran France about a century ago, and devoured a very large proportion of the crops, but fortunately the corn was not attacked. The antler moth is sometimes extremely destructive to grass crops. Mr. Napier once saw millions of these on the Wrekin, and in the following summer the grass of that moun-

tain was in a miserable state. The lackey moth is very destructive to filbert plantations, cherry orchards, and other tree plantations. The buff tip, the cabbage moth, and the small ermines, are very destructive to the leaves of fruit trees and garden shrubs. But, on the other hand, the benefits derived from the labour of some insects should not be overlooked; some species feed only on noxious weeds, and others prey on still more noxious insects. One of the greatest friends of the agriculturist is the family of ichneumon flies, which lay their eggs in the bodies of living caterpillars, in which they are hatched, thus destroying them; although the caterpillar, after being "ichneumoned," has still a voracious appetite. The caterpillars which feed on the cabbage eat twice their weight in a day; the larvæ of some of the fleck flies eat a much larger proportion than this. The productive powers of insects vary very much. Some lay only 2 eggs; others, such as the white ant, 40 millions, laying them at the rate of 60 a minute. The queen of the hive bee is capable of laying 50,000 in a season; the female wasp 30,000. The majority of insects however, lay but about 100; in general, the larger the insect, the fewer eggs it lays. Most insects have 2 generations in the year; some have 20; others take seven years from the time the egg is laid until their natural death in a perfect state. But probably not above 5 per cent. of the eggs laid become perfect insects. Among the flies the daddylonglegs is one of the most destructive, especially in France; it feeds on the roots of grass, and Mr. Napier in 1859 noticed meadows in La Manche devastated by it. The starling is a bird most useful in destroying these larvæ, and those of the horse and cattle flies. The orthopteris insects, of which the locust, grasshopper, and cockchafer are examples, are very destructive. The numerous species of grasshoppers lessen the amount of our grass crops. Locusts are seldom found in England now in sufficient numbers to do any damage, but they have done considerable damage here in former generations. Their greatest enemies are the starling and the rose-coloured pastor, which follow them in flocks and decapitate them by hundreds. The beetles are immensely numerous, as regards species. In 1574 the cockchafers gathered in such numbers on the banks of the Severn as to prevent the working of the watermills. On another occasion, in Galway, they formed a black cloud that darkened the sky for the distance of a league, and destroyed the vegetation so completely that summer seemed turned into winter. They made a noise resembling the sawing of wood. The people, threatened with famine, were obliged to devour them. In 1804 they were alarmingly numerous in Switzerland. The female lays about 30 eggs; in six weeks they are hatched. They live from three to four years in the larvæ state. The first year they do not do a great amount of damage; but in the second year they attack the roots of all plants within their reach. They often ruin the crops of corn, lucerne, strawberries, and various plants on which man depends

for food. In a field of 29 acres in France, above 43,000 larvæ were found—quite sufficient to destroy the entire crop during the season. Our insectivorous birds are diligent in destroying the larvæ of insects, but they will not do all that is required; hand labour is also needed. Mr. Napier is of opinion that the extensive diffusion of information on the habits and means of destroying our more noxious insects would be the means of saving millions of pounds' worth of valuable food every year. He says that in the United States the importance of this subject is felt, and almost every State has a Government entomologist, whose business it is to make inspections and reports of the ravages of insects, and show the remedy. In France Government returns were published, from which it appeared that the damage done in Normandy by the cockchafers alone amounted to 25 million francs A law was passed in France a few years since for the protection of birds. Not, however, that all birds are to be welcomed; the sparrow does more harm than good, by feeding so much on green crops, and the wood pigeon does much mischief. But on the whole Mr. Napier is certain our birds do a great deal more good than harm.

BREEDING OSTRICHES.

A PAPER appears in the *Bulletin Mensuel* on the Breeding of Ostriches in captivity, contributed by Capt. Crepu, who has kept several pairs of these birds. His observations throw much light on the natural history of the ostrich.

MORTALITY AMONG DEER.

M. COMBER describes the mortality which has seized the deer and other animals in King Victor Emmanuel's park at La Mandria. The calamity is attributed partly to over-crowding and partly to the want of shelter and proper protection. In 1865, when the park and grounds were carefully cultivated, 13 deaths occurred. In 1873, the park being left in its natural state, 172 deaths are recorded.—*Nature.*

CARRIER-PIGEONS FOR WAR-TIME.

THE Paris *Liberté* states that "the Fortifications Committee has adopted a decision upon the interesting question of military pigeon-houses, which General Cissey, when Minister of War, had referred to it for consideration. The conclusions recommend the formation of an extensive pigeon-house in the grounds adjoining the Jardin d'Acclimatation, the director of which institution will be intrustsd with the rearing of carrier-pigeons. The Government is to keep there during the next five or six years 5,000 pairs of pigeons for breeding purposes. Each fortress is to possess a military pigeon-house, constructed upon a model which is still under consideration, and each pigeon-house will contain 1,000 birds. There are to be established also

two general stations to meet the eventuality of another invasion, and 60,000 pigeons will be kept at these stations. We must remember that the Germans have anticipated us in this matter, and that Metz and Strasburg have been for a year past connected with the fortresses of the German Empire by a system of carrier-pigeons."

CROCODILES AND FISH.

Dr. Day, in his Report on the fisheries of India, gives an interesting notice of the extent to which Crocodiles will destroy Fish. There are two distinct genera of crocodiles in India. The first of these is the true fish-eating crocodile (*Gravialis Gangeticus*, Gmelin), which attains upwards of 20 ft. in length, and is found in the Indus, the Ganges, and other large rivers. This species has a long and slender snout; it is usually timid of man, excepting when the locality where its eggs are deposited in the sand is invaded. It does not appear to feed on carrion, but fish, turtles, and tortoises form its diet. In 1868 it was deemed one of the sights at Cuttack to watch these enormous reptiles feeding below the irrigation weir, which was impeding the upward ascent of the breeding fish. Their long brown snouts would be seen rising to the surface of the water, with a fish cross-wise in their jaws. Their finny prey was flung up into the air by a toss of the head, and descending head foremost, fell into the captor's comparatively small mouths. They are very prolific. A single gun has been known to destroy 69 out of one brood in three hours' shooting. But some fishermen, when asked whether they ever kill the crocodiles, at once protested against such a course. Their argument was, "Are we not both of the fish-destroying races, and how could we be so cruel as to slaughter them?" As to the destruction committed by these creatures, they merely remarked that they would themselves do the same if they could, and in this undoubtedly they spoke the truth. However, it is not to be expected that fishermen should bestow their time in destroying young crocodiles, and they do not carry guns to shoot the full-grown animals. Neither will the native sportsmen waste their ammunition on crocodiles which are of no use to them when killed. The means proper to reduce their number are to offer rewards for the destruction of their eggs.

The common crocodile (*Crocodilus palustris*) also abounds in India, and though usually termed man-eaters, they assist in depopulating the waters of fish; and it is only when the finny tribes or carrion are scarce that they will attack the larger mammals, including man; but, having once tasted blood, they appear to be eager to do so again. In some of the irrigation canals one or more of these creatures may usually be seen below the locks, where there are pools stocked with fish, and when the latter fail they will turn their attention to the cattle. Dr. Day, in 1868, noticed four below a large weir at Cuttack; six weeks

afterwards they had increased to nine, besides many little ones; and he calculated that the fish they were then consuming day by day would be worth more than 22 rupees. His suggestion to give five rupees apiece as a reward for the destruction of these animals was disregarded; and supposing those nine crocodiles had not increased, and that the young ones never lived to grow up, they would still have consumed fish to the value of 2,873*l.* in the three and a-half years to the middle of 1872, all which might have been avoided by an outlay of 45 rupees at the time referred to. But the ravages of crocodiles are not confined only to the fish. Compelled by hunger, they will help themselves to cattle, or else feed on human beings who may approach incautiously near the water. Thus, there is a hole on the River Nuna to which crocodiles in the dry season will resort. Of course the fish in such pools are soon exhausted, and in 1868 these monsters carried off five adults. So also near the Baropa Weir two women and one horse were devoured by crocodiles in a single month. Their one redeeming quality is that they are the natural scavengers of the rivers. This, however, is only true of the common crocodile; and as the fisheries of India are deteriorating, these large fish-eating reptiles ought to be energetically reduced, as they are no longer required in such numbers as before, even if we concede full force to the arguments of those who are for maintaining the balance of nature on every side. —*Land and Water.*

EGGS OF CUTTLEFISHES.

MR. HENRY LEE, F.L.S., writes in *Land and Water*:—"I described three weeks ago the spawning at Brighton of an Octopus, and the manner in which she gently nurses her cluster of eggs as in a cradle, in the boat-shaped or trough-like membrane of one of her arms. She still continues to attend to them with the utmost care, seldom leaving them even for an instant except to take food, which, without a momentary abandonment of her position, would be beyond her reach. Here again the old naturalist of Stagira was not quite correct in his opinion. He asserts that while the female is incubating she takes no food, and consequently becomes weak and exhausted, and reduced in size. In the tank with our specimen are seven others of her species, and to supply them with food about 25 living shore crabs (*Carcinus mænas*) are daily tossed into it. Although she so seldom leaves her nest she generally obtains her share of these, and I have seen her seize with her suckers, and draw towards her three at a time, one by each of three of her arms. Their shells are soon crushed and broken up by her powerful beak, and when she has devoured the contents the hard *débris* is cast out of her den. Although Aristotle was mistaken in supposing that the female octopus does not take food during the period of the development of her ova, I think he was right in believing

that her anxiety for her progeny, and her unremitting care of them, tell injuriously upon her health. A sitting hen bird loses flesh while hatching her eggs, and I sometimes fancy that our lady octopus shows signs of diminishing bodily vigour. Her respiration at times appears to be laboured. When the water is inhaled (I use the word intentionally, for the animal breathes the oxygen contained in it) at the open part of the mantle-sac, the siphon-tube, at its orifice, is often drawn forcibly inward; and when the pair of bellows of the body close, the same opening of the tube is distended to its fullest capacity by the outrush of the exhaled water. The female octopus often turns the mouth of the tube, as the fireman does the nozzle of his hose-pipe, so as to direct a jet of the ex-current water on her eggs—for what purpose I am unable to say. My opinion is that no actual incubation is necessary, and that it does not take place. I believe that the attention of the mother to them is for the purpose of guarding and protecting them from injury, and preventing them being devoured by fishes and by others of her family, possibly by her own husband. Until lately neither I nor any living naturalist knew anything of the eggs of the octopus, nor of its breeding habits; but at intervals, for many years past, I have found the eggs of the *Sepia* and *Loligo* in early stages of their development, and have hatched them out, without any assistance from their parent at the sea-side by merely suspending them in a tank or tub, and changing the water frequently. The same was done by my deceased friend, John Keast Lord, at the Brighton Aquarium last year, and is now again in progress there with the ova of both these species. In some of the grape-like eggs of the *Sepia*, which were brought in a fortnight ago, the young cuttles have since advanced considerably towards perfection of form. At first the little animal has the head and eyes disproportionately large, but gradually acquires a greater resemblance to its parent. If the black integument be removed, as one would skin a grape, it may be seen moving in the fluid which fills the egg. Cut down to the little living grape-stone under water, and away it will swim, with all its wits about it, and in possession of all its faculties, with as much facility and self-possession as if it had considerable knowledge of the world. It sees and avoids every obstacle, and if you take it out of the water, in your hand, the precocious little beggar, not a minute old, will spurt its ink all over your fingers. You may tame an old cuttle-fish, and it will learn to know that you are a friend, and intend to do it no harm; but the youngsters are as shy as human babies, and regard every one but their mother as an enemy."

THE STICK-FISH, AND THE HABITS OF SEA-PENS.

MR. COOTE M. CHAMBERS has most kindly presented to the British Museum a specimen of the Stick-fish, from English Bay, Burrard's Inlet, British America. The specimen was placed

alive, immediately it was caught, into a tin tube, filled with a solution of arsenic and salt.

Mr. Chambers observes that the Stick-fish are only to be found in Burrard's Inlet, English Bay, British Columbia. "It has only one bone in it, and appears to live on suction, and is a great prey to dog-fish." Further: "I would mention that in summer only can they be caught. They are found to the least depth of from 30 to 40 fathoms; they move about rapidly in the water, and when brought to the surface move for a few seconds like a snake, then make a dart as swift as lightning, and disappear."—July 23, 1873.

Unfortunately, the specimen did not arrive in a good state for exhibition. The greater part of the animal portion had been washed off, probably by the motion of the solution during the transit; only about a foot of the flesh, which was loose on the axis, and the thick, swollen, naked, club-shaped base without polypes, remained; but it was in a sufficiently good state to afford the means of determining its zoological situation and of examining its microscopical and other zoological characters.

Mr. Chambers's specimen is the animal of the axis, or stick, described as *Osteocella septentrionalis* (Ann. and Mag. Nat. Hist. 1872, ix. p. 406), and it proves that the axis belongs to a kind of *Pennatula*, or Sea-pen, nearly allied to the long Sea-rushes named *Pavonarius quadrangularis*, found on the West Coast of Scotland, and is evidently the same animal as *Pavonaria blakei*, described by R. E. C. Stearns. The idea of its being a fish, which seems so generally entertained by the people of British Columbia, is clearly a mistake, though one of the observers sent a figure of the Sea-pen, with mouth and eyes like an eel (!), which is copied in *Nature*, vol. vi. p. 436.

The habits of *Pennatuladæ* are very imperfectly known, and not at all understood. Dr. Johnston observes, in the *British Zoophytes*, vol. ii. p. 160, that the fishermen believe the common Sea-pens, which they call "coxcombs," are fixed to the bottom, with their ends immersed in the sand.

Osteocella.—The complete polype mass very closely resembles *Pavonaria quadrangularis*, as figured by Johnston ("British Zoophytes," t. xxxi.), from Professor Edward Forbes's drawings; but the animal is entirely covered with calcareous spicules, and the axis is cylindrical, hard, and polished.

The *Pavonaria quadrangularis*, according to Professor Forbes, "lives erect, its lower extremity, as it were, rooted in the slimy mud at a depth of from 12 to 15 fathoms." Mr. Darwin, who observed a species on the coast of Patagonia, which he called *Virgularia Patagonica*, says: "At low water hundreds of these zoophytes may be seen projecting like stubble, with the truncate end upwards, a few inches above the surface of the muddy sand. When touched or pulled, they suddenly draw themselves in with force, so as nearly or quite to disappear. By this action, the highly elastic axis must be bent at the lower extremity,

where it is naturally slightly curved, and I imagine it is by this elasticity alone that the zoophyte is enabled to rise again through the mud."

Bohadsch, as quoted by Johnston, says that *Pennatulæ* swim by means of their fins, which they use in the same manner that fishes do their fins. Ellis says: "It is an animal that swims freely about in the sea, many of them having a muscular motion as they swim along." And, in another place he tells us, that "these motions are effected by means of the pinnules or feather-like fins, which are evidently designed by nature to move the animal backwards and forwards in the sea, and consequently to do the office of fins." Mr. Clifton describes the Australian species as swimming rapidly in shallow water; and the American naturalists all seem to agree that the Stick-fish, *Osteocella septentrionalis* of Burrard's Inlet, which has only a slight crest of polyps, and not *prinnæ*, or fins, as Ellis calls them, swims about like a fish, and is eaten by the dog-fish.

There seems to be no doubt that the Sea-pens and Sea-rushes live in groups together, erect and sunk in the mud, and that they are sometimes found swimming free in the sea; but the question is, are the free specimens those that have been disturbed by the waves and currents, and do they afterwards affix themselves in the mud; or are they vagrant specimens that live for a time, and then die, or are eaten by fish, their struggling being mistaken for swimming? Dr. Johnston observes, that when the Sea-pens are placed in a basin or plate of water, he never observed a change of position, but they remain in the same place and lie with the same side up or down, just as they have been put in. We abridge these details from a very interesting paper in *Nature*.

FACTS ABOUT SNAKE-BITES.

DR. R. DRUITT writes from India that in Madras, in 1870–71, the number of human lives said to have been destroyed by beasts of prey and poisonous snakes was 2,225, and the number of cattle 5,314. The rewards paid for killing tigers, &c., amounted to 2,511*l*. Only 2*l*. 14*s*. was spent in rewarding the destruction of snakes. But an official return for the year from April 1, 1872, to March 31, 1873, shows a very different state of things. In March, 1872, seventy-four snakes were destroyed in the whole Presidency, and the reward of two annas, or 3*d* for each poisonous snake, amounted to 18*s*. 6*d*. But month by month the serpenticidal zeal of the population was more and more aroused, till, in March 1873, the number of snakes destroyed was 425,057, and the rewards not less than 5,313*l*. 4*s*. 1½*d*. Taking the year as a whole, the number of snakes destroyed in the Presidency was more than one million and a quarter, and the money paid in rewards was 15,728*l*. 16*s*. 9*d*., which numbers would have been trebled had every part of the Presidency been equally

zealous. The Madras Government seems to have repented of its liberality, and to have thought that even snake-killing might be too dear; therefore, by an order dated May 28, 1873, they have restricted the reward to cobras only, and have fixed it at one anna, or $1\frac{1}{2}d.$ per cobra. It was alleged that some of the natives used to breed cobras on purpose to get the rewards; but considering the immense quantity of land which seems not to be cultivable profitably for human food, and which is covered with prickly pear and other wild plants, there really seems to be no limit to the number of snakes which might be captured. Very few cases of snake-bite in India are seen by European or medical authorities. The poison is too rapid. We get an incidental glimpse occasionally, from indirect sources, of the details. For instance, in the *Report of the Society for the Propagation of the Gospel*, a poor Christian thus describes the death of his daughter:—"Three months after her marriage, in a field in the wilderness, a snake bit her. Her husband dragged her towards home as far as he could. Her legs were cut by the stones, and bleeding. When he could carry her no longer, he laid her near a thicket, and ran for help, but the ants had begun to eat her face before he could return." It must in candour be said that some authorities consider the accounts of the numbers of men and animals destroyed by snakes very much exaggerated, and affirm that many women and others who are murdered are said to have died from snake-bite. On this point we can offer no opinion. Certain it is that nothing is more rare than to hear of Europeans bitten.—*London Medical Journal.*

THE MICROSCOPE.

In *Der Naturforcher* has appeared a useful résumé, by Mr. W. Archer, of recent observations on Parasitic Algæ, followed by Dr. Klein's Contributions to the Anatomy of Auerbach's Plexus in the Frog and Toad; and this by a valuable series of observations by Professor Lister on the Natural History of Bacteria, in which a study of the life of Bacteria under different circumstances as regards the fluid in which they grow, shows that their general appearance, size, and shape, depend in great measure on the fluid in which they are growing, their removal from one to another fluid causing them to take on quite a different form, and their replacement the reassumption of the original condition. Many important facts are to be learned from this paper.

THE HONEY-BEE.

At the Canterbury meeting of the East Kent Natural History Society, Major Munn brought no less than twenty-four live young of the Honey-bee, and gave practical demonstrations of the following fact:—Major Munn proceeded at once to give very strong evidence in favour of the fact that the queen bee does

not and cannot sting. The most conclusive evidence in favour of this fact was afforded by the handling of the queens both by the Major himself and by other members of the Society; for in no case did these insects sting; not from a want of will to do so, however, since they were seen to put out their stings and attempt to inject their poison into the hand which held them in captivity. But in no case were they able to penetrate with the sting the skin of the human body. Major Munn then referred to the comparative structure of the sting in the queen and worker bees, held as affording an explanation of the inability of the queen to sting. As shown by Mr. George Gulliver, jun., the sting of the worker is very sharp, straight, and provided with from eight to ten barbs, while the sting of the queen is curved, much blunter, and provided with but few barbs. It having been stated that the queen bee is unable to sting, the question naturally arises, "But how does she kill her rival, since it is a well-known fact that two queens will fight like game-cocks?" This question the Major proceeded to set at rest practically by putting two queens together in a glass bottle, in order that their fighting might be witnessed by the Society. During the fight, which was watched with the most intense interest, each queen was seen to attempt to disable her rival as much as possible by means of her powerful mandibles, an account of the structure of which had been given by Major Munn. At the same time she feels about with her sting, which is totally unable to penetrate the integument of her rival, till she finds one of her spiracles—that is, one of the respiratory apertures of her rival—through which she injects her poison, with a rapidly fatal effect, into the respiratory system.

During the progress of the fight, Major Munn gave a most amusing account of the tricks of Thomas Wildman, who flourished towards the latter part of the last century, and had at that time the reputation of having the most surprising command over bees. He was accustomed to exhibit himself, surrounded with his bees, before the king and divers of the nobility. "Thus fortified, bulldogs have been set at him by his own desire, when he repulsed them by detaching one or two bees, to the astonishment of all who have seen him." He was offered 100 guineas as a reward if he would disclose the secret, which he refused to do. All the tricks of this man were explained by Major Munn. Wildman's apparent command over bees was simply owing to his using only queen bees, and these could not sting him. Possessed of this secret, he could handle the bees fearlessly, and detach them against the dogs, who, when the insects were entangled in their hair, were frightened by their buzzing.—*Land and Water.*

THE ZOOLOGICAL SOCIETY'S MENAGERIE.

THE Report on the additions made during December 1873 called special attention to a female Onager, or Wild Ass, and a

pair of the new Japanese Storks (*Ciconia Boyciana*). Also to a pair of the Spotted Wild Cat (*Felis torquata* of Jerdon). Dr. A. L. Adams exhibited and made remarks on the Horns of a feral race of *Capra hircus*, from the Old Head of Kinsale. Letters and communications were read: by Mr. P. L. Sclater, on the species of the genus Synallaxis, of the family Dendrocolaptidæ: the specimens of this difficult group in nearly all the principal collections of Europe and America had been examined, and the existence of fifty-eight species ascertained, besides three of which the types were not accessible, and which were considered to be doubtful,—by Mr. G. Busk, on a New British Polyzoon, proposed to be called *Hippuria Egertoni*, after Sir Philip Egerton, who had discovered it growing upon the carapace of a specimen of *Gonoplax angulatus*, dredged up at Berehaven in the course of last summer,—by Mr. A. Sanders, on the myology of *Phrynosoma coronatum*,—from Dr. J. E. Gray, containing a description of the Steppe-Cat of Bokhara, which he proposed to designate *Chaus caudatus*,—by Sir V. Brooke, Bart., on Sclater's Muntjac and other species of the genus Cervulus. In pointing out the distinctions which characterise the three existing species, *Cervulus muntjac*, *C. Sclateri*, and *C. Reevesii*, the author showed *C. Sclateri*, the species of most northern range, to be intermediate in specific characters and size between the two others. Sir Victor pointed out an advance in the specialisation of the tarsus thus not hitherto observed. In this genus the navicular, cuboid, and second and third cuneiform bones were anchylosed together and formed one single bone, the first cuneiform being represented by a very small and separate bone,—by Sir V. Brooke, Bart., on a new Species of Deer from Persia, a pair of horns of which he had received from Major Jones, H.B.M. Consul at Tebreez in Persia, and which he proposed to call *Cervus Mesopotamicus*,—by Major H. H. Godwin-Austin on some birds obtained by him in 1872–73 along the main water-shed of the Brahmaputra and Irrawaddy rivers: of these, ten were considered as new to science, viz., *Sitta Nagensis*, *Garrulax galbanus*, *G. albosuperciliaris*, *Trochalopteron cineraceum*, *T. virgatum*, *Actinodura Waldeni*, *Layardia rubiginosa*, *Prinia rufula*, *Cisticola munipurensis*, *Munia subundulata*,—by Mr. Garrod, upon the morbid symptoms presented by the Indian Rhinoceros that had lately died in the Society's Gardens, and upon certain points in its anatomy,—by Mr. E. C. Reed on the Chilian species of the coleopterous families Cicindelidæ and Carabidæ.

SILKWORMS.

A FREIGHT car loaded with silkworms' eggs lately passed over the Pacific Railroad from San Francisco to New York. They were from Japan, and were consigned to a Paris house. The weight of the eggs was 9½ tons, and they were valued at over $2,000,000. They were packed upon leaves, layer upon

layer, and placed in air-tight tin boxes, which were again enclosed in matting, while the car was kept carefully darkened and at a temperature below freezing-point.

In the *Chronique de la Société d'Acclimatation*, M. Ruimet states that by feeding silkworms on vine-leaves he has obtained silk of a fine red colour; and that by giving the worms lettuce-leaves they have produced cocoons of an emerald-green colour. M. Delidon de St. Gilles, of Vendée, has also, by feeding silkworms—during the last twenty days of the larva period—on vine, lettuce, and nettle-leaves, obtained green, yellow, and violet cocoons.

THE DEPTHS OF THE SEA.*

It was not until about thirty years ago—so new is the whole subject—that men began even to suspect the existence of a deep-water world. No life, they held, could exist in that total darkness, under a pressure of water so enormous that, as Dr. Wyville Thomson says, a man at 2,000 fathoms' depth would bear on his body a weight equal to 20 locomotive engines, each with a long goods train loaded with pig iron. Had they known likewise that living creatures down below would have to contend with all but freezing cold, they would have seemed to themselves even more justified than they actually were in their mistake.

It is difficult at first to conceive this certain rule when we apply it to water under immense pressure. We fancy that water, in that case, must stiffen or harden, forgetting that it remains, being all but incompressible, as liquid as ever, and that its particles, as far as we know, slide as freely over each other at 5,000 fathoms' depth as at the surface.

A slight sketch of the gradual discoveries of the teeming life of the Deep Sea may not be without interest; and all the more because the truth showed itself, as most truths do, not suddenly and once for all, but with forecastings and hints given, and sometimes given in vain, to those who, with minds preoccupied, were not prepared to see what nature was trying to make them see.

As late as 1859 men were acquiescing in the theory of the late lamented Edward Forbes—that in the zone of deep-sea corals, supposed to reach only some 100 fathoms down, the inhabitants of the region "became more and more modified, and fewer and fewer, indicating an approach towards an abyss where life is either extinguished or exhibits but a few sparks to mark its lingering presence." If Edward Forbes had lived but a few years more, with what hearty delight would he, above all men,

* *The Depths of the Sea.* An account of the general results of the dredging cruises of Her Majesty's ships "Porcupine" and "Lightning," during the summers of 1868, 1869, and 1870, under the scientific direction of Dr. Carpenter, F.R.S., J. Gwyn Jeffreys, F.R.S., and Dr. Wyville Thomson, F.R.S. By C. Wyville Thomson, LL.D., &c. London, Macmillan and Co. 1873.

have welcomed the discovery that he was quite mistaken! Yet, before his time, a significant hint or two had been sent up out of the nether darkness. As early as 1818 Sir John Ross, taking soundings in Baffin's Bay in 1,000 fathoms, had brought up, among other live creatures, a beautiful "Medusa's head" starfish. In 1839–1843 Sir James Clark Ross had brought up numerous species of live animals from 270 fathoms in the Antarctic Ocean, and among them a shrimp (*Idotea Baffini*), supposed to be peculiar to the Arctic Seas—one of the first instances—many more have been found since—of the remarkable range of similar forms at the bottom of the ocean through many parallels of latitude and longitude, which is to be explained by the uniformity of the conditions under which they live; uniformity in the materials of the sea-floor, and in the low temperature of the water overlying it. In 1845, again, Henry Goodsir—one of the martyrs of science, for his body now lies amid the Arctic ice with Sir John Franklin and his crew—brought up in Davis Strait out of 300 fathoms "a capital haul," as he phrased it, of living creatures, of at least four of the lower animal sub-kingdoms. Then followed that series of attempts to sound the North Atlantic Ocean, so honourable both to the Government and the Navy of the United States, which ended in the laying down of the Atlantic Cable. By Brooke's sounding apparatus, invented for the occasion, the 2,000 fathom plateau between Cape Clear, in Ireland, and Cape Race, in Newfoundland, was discovered to be bedded almost entirely with fine soft ooze, very similar in its composition to our own chalk, and full of the shells of minute organisms (*Foraminifera*), many species of which—some 19 out of 110—were found to be identical with species fossil in the chalk, and with some in even older rocks; and naturalists beheld, with something of astonishment and awe, tiny creatures still living and thriving, who had endured, generation after generation, unchanged through countless ages, while all around them—living creatures, distribution of land and sea, and, it may be, the climate of the whole planet—had changed again and again.

Yet it was considered doubtful—and that by some of the highest living authorities—whether these atomies had lived where they were found. It seemed more probable that they had floated freely at higher levels, as millions of equally exquisite atomies do, and that their shells had sunk to the bottom after death.

Then followed, in 1860, Sir Leopold M'Clintock's Sounding Expedition to Iceland, Greenland, and Newfoundland in Her Majesty's ship *Bulldog*, with Dr. Wallich as naturalist. In his voyage, not only was it made probable that the *Foraminifera* lived in the ooze in which they were found, but starfishes, of forms supposed till then to belong exclusively to shallow water, were brought up clinging to the sounding line from the depth of 1,260 fathoms. In the autumn of the same year a discovery

was made in the Mediterranean which far surpassed the previous discoveries, by Edward Forbes and Captain Spratt, of deep-sea life in the Mediterranean at 300 fathoms. This, strangely enough, consisted in many cases of species belonging to the North Atlantic; for when the electric cable between Sardinia and Bona in Africa was taken up for repairs by Professor Fleeming Jenkins, it was found to be coated with living parasites down to the depth of 1,200 fathoms. Thus was proved beyond a doubt the presence of life, abundant, varied, and beautiful, in the Mediterranean Sea under the pressure of a mile and a half of water. Meanwhile, our Scandinavian cousins had not been idle. Professors Loven, Keferstein, and Sars (father and son) had proved, both from the Swedish Spitzbergen expedition and from the dredgings of M. Sars the younger, that a whole similar world of lower animals existed in the Northern seas at a depth reaching to 1,400 fathoms. Next—for facts began now to accumulate fast—M. Barboza da Bocage, Director of the Natural History Museum in Lisbon, "surprised the zoological world" in 1864 by the news that "glass-rope sponges" (Hyalonema), supposed till then to be peculiar to Japan, were brought up by the lines of the Setubal shark fishers, who were working—also a novel fact—in 500 fathom water; so that their sharks always came up dead, choked and blown-up by the expansion of the air inside them in the rapid passage out of immense pressure to the freer surface. Just so did the large and novel fish which the *Challenger* trawled the other day off Cape St. Vincent in 600 fathoms come up, not with water, but with air on the brain, their eyes protruding like globes from their heads.

Looking at all these rapidly accumulating facts, Professor Wyville Thomson and Dr. Carpenter, in the spring of 1868, conceived the plan of those successive Government expeditions, the latest of which is that of the *Challenger*. "The only remaining region," it seemed, where the naturalist could find "endless novelties of extraordinary interest," was the bottom of the deep sea. The oscillations of the northern portion of the northern hemisphere have not ranged much beyond 1,000 ft. since the beginning of the Tertiary epoch—a fact from which Dr. Wyville Thomson shrewdly drew the inference that a vast area of the deep North Atlantic must have remained unchanged by those movements, and might, therefore, yield living animals, or at least their modified descendants, which had bred on, generation after generation, since the days when our chalk was still at the bottom of the sea. The Admiralty, at the instance of the Royal Society, lent in 1868 the surveying ship *Lightning*, and, encouraged by the success of her trip, lent in 1869–70 the more perfectly equipped *Porcupine*; and the cruises of these vessels in the North Atlantic, from Shetland and the Faröes to Rockall, and the deep ocean to the West and South-West of Ireland—in which last area the dredge was successfully used at the enormous depth of 2,090 fathoms—then down the coasts of Portugal and

Spain to Gibraltar, and thence up the Mediterranean as far as Messina and Malta, have disclosed a world of new wonders, the most startling of which are described in this book. The practical mechanician may find, in the chapter on deep-sea sounding and dredging, the details of a whole new art, down to that crowning invention of Captain Calver's, worthy of the inexhaustible craft of a true British sailor; for, finding that while very few things came up inside the dredge, many came up sticking to its outside, and even to the rope, he "initiated a new era in deep-sea dredging" by making fast to the bottom of the dredge half-a-dozen deck-swabs, and swept the sea-floor with such effect that in one case "not fewer than 20.000 examples of a certain little sea-urchin came up on the tangles at one haul."

The nether darkness, then, so far from being a lifeless waste, teems almost everywhere with creatures not only more fantastic, but larger, than their shallow-water cousins; and the paddler about rock-pools and tide-sands at watering-places will learn from this book that far away at sea, over that 100 fathom line to the westward which marks the ancient shore of the European continent, are found sea-monsters far bigger, as well as far uglier and far more beautiful than were ever transferred to an aquarium; that, to give two instances, the Caprella, "the phantom-shrimp," which may be found on sea-weed, sitting upright like a monkey, holding on by his hind claws, and, with ghastly grimaces, mesmerizing all passers-by with his fore-claws, sits in like guise upon sponges a mile or two deep in the darkness—there, however, not a quarter of an inch but three inches long; and that the Nymphons—sea-spiders who crawl out from under stones, and who, having no body to speak of, carry their stomach, for economy of space, packed in long branches up the inside of each leg—are found in the depths of the Arctic Sea, not, as here, half-an-inch, but two feet in diameter.

It is impossible to give even a sketch of the zoological treasures which have been brought to light by these cruises of the *Lightning* and *Porcupine*, not forgetting those of the Swedish naturalists and of the yacht *Nona*, whose owner, Mr. Marshall Hall, we hope may be emulated by other yachtsmen. Among their discoveries are true worms, sea-urchins, star-fish, including the magnificent and novel Brimiga, worthily named after the goddess Freya's favourite jewel, Crinoids ("stalked flowers of living stone"), corals, and above all sponges of forms either new or till now known only as fossil or, strangely enough, as inhabitants of shallow water. But the strangest, as well as the most beautiful, inhabitants of the deep-sea ooze are the glassy sponges, in which the skeleton is composed, not of horny fibres, as in the sponges of our dressing-rooms, but of flexible flint, often more delicate than the finest spun glass. The best known of these is the Venus's flower-basket, or Euplectella, which lives imbedded in the mud of the seas of the Philippines, supported by a glass frill "standing up round it like a Queen Elizabeth's

ruff." Twenty years ago there was but one known specimen in Europe. It may be now bought for 30s., or less, in any curiosity shop; and it is strange that this—one of the most exquisite, both in form and texture, of all natural objects—is not often seen, even already, as a drawing-room ornament. Equally curious, even more puzzling in its construction, is the glass-rope sponge, or Hyalonema, which roots itself in the mud by a twisted wisp of strong flint needles, somewhat on the principle of a screw-pile. So strange and complicated is its structure that learned men for a long while could literally make neither head nor tail of it, as long as they had only Japanese specimens to study. Which was top and which bottom, which the thing itself, and which parasites growing on it; whether it was a sponge, or a zoophyte, or something else, could not be settled, and is in some men's minds scarcely settled now. But the discovery of the same, or a closely allied species, in abundance from the Butt of the Lews down to Setubal, on the coast of Portugal, where the shark-fishers call it "Sea-whip," has given our *savans* specimens enough on which to make up their minds, and has added another form to the list of those common, strangely enough, to our seas and to those of Japan. Scarcely less beautiful and strange are the Holtenias and their cognate forms; hollow sponges built up of glassy spicules, and rooted in the mud by glass hairs, in some cases between 2ft. and 3ft. long, as flexible and graceful as tresses of snow-white silk.

If any one wishes to gratify at once his curiosity and his sense of beauty, let him go up the great staircase at the British Museum, and, on entering the second corridor, turn either right or left to the cases which contain these sponges and other deep-sea forms—to which, by-the-by, in the present crowded state of the Museum, ghastly troops of monkeys serve as a foil—and there see how Nature is not only "*maxima in minimis*," greatest in her least, but "*pulcherrima in abditis*," fairest in her most hidden works; and how the Creative spirit has lavished, as it were, unspeakable artistic skill on low-organised forms, never till now beheld by man, and buried not only in foul mud, but in the unsightly mass of their own living jelly.

But so it was from the beginning; and this planet, with its complicated wonders and beauties, was not made for man alone. Countless ages before man appeared on earth, the depths of the old chalk ocean teemed with forms as beautiful and as perfect as those, their lineal descendants, which the dredge now brings up from the Atlantic sea-floor.—Abridged from the *Times*.

BOTANY.

REMARKABLE PLANTS.

PROF. LAWSON has described to the British Association the plants collected by the voyager Dampier, which are preserved in the Sherardian Herbarium at Oxford. A communication to Dr. Hooker, from the African traveller, Mr. Baines, gave an account of a remarkable tree Aloe, which he had met with near Grey Town, in south-eastern Africa. It was about twenty feet high, with a trunk two feet thick. Dr. Hooker gave an interesting account of the Subalpine vegetation of Kilima-'njaro, the loftiest mountain hitherto discovered in Africa, from a collection made by a missionary, Mr. New, who, at the instigation of Dr. Kirk, had preserved recognizable specimens of some fifty species in a couple of old *Guardians*. It was remarkable as containing one peculiar plant, hitherto only known from the Cameroons Mountains, on the western side of Africa. The general conclusion, from the examination of the collection, appeared to be that South African plants had migrated north of the equator to a greater extent than European types had south of it.—*Athenæum*.

INNER LIFE OF PLANTS.

PROF. J. B. SANDERSON, M.D., has given to the Royal Society an account of his recent discovery respecting the electrical phenomena which accompany the irritation of certain leaves. It is a well-established fact that electric currents occur in animal muscle, but it has not hitherto been demonstrated that a similar principle pervades the vegetable world. The doctrine of protoplasm and the fundamental agreement as to the cause of contraction in all living substances are much affected by this new discovery, and it is not at all unlikely that the contracted substance both in muscle and in vegetable tissue may be proved to be protoplasm. Anyhow, it throws considerable light upon the nature of contractile substances in general. Professor Sanderson was led to investigate in this direction from a conversation he had with Mr. Darwin; his experiments are simple, and can be easily repeated and verified. (See the experiments described at pp. 139–41, *Electrical Science*.)

TREE VILLAGE AT ISABEL ISLAND.

AMONG the papers presented to Parliament, says the *Times*, relating to the South Sea Islanders, is a report by Captain C. H. Simpson, of her Majesty's ship *Blanche*, giving an account of his visit last year to the Solomons and other groups of islands in the Pacific Ocean. While at Isabel Island, Captain Simpson, with a party of officers, went a short distance inland to visit one of the remarkable tree villages peculiar, he believes, to this island. He found the village built on the summit of a rocky

mountain rising almost perpendicular to a height of 800 ft. The party ascended by a native path from the interior, and found the extreme summit a mass of enormous rocks standing up like a castle, among which grow the gigantic trees in the branches of which the houses of the natives are built. The stems of these trees lie perfectly straight and smooth, without a branch, to a height varying from 50 ft. to 150 ft. In the one Captain Simpson ascended the house was just 80 ft. from the ground; one close to it was about 120 ft. The only means of approach to these houses is by a ladder made of a creeper, suspended from a post within the house, and which, of course, can be hauled up at will. The houses are most ingeniously built, and are very firm and strong. Each house will contain from ten to twelve natives, and an ample store of stones is kept, which they throw both with slings and with the hand with great force and precision. At the foot of each of these trees is another hut, in which the family usually reside, the tree-house being only resorted to at night and during time of expected danger. In fact, however, they are never safe from surprise, notwithstanding all their precautions, as the great object in life among the people is to get each other's heads.

CHANGES IN COLOURING MATTER OF LEAVES AND FLOWERS.

MR. H. C. SORBY has explained to the Naturalists' Club of Sheffield some investigations upon which he is now engaged. He stated that he had studied the changes that had occurred in the Colouring Matter of Leaves and Flowers during their development from a rudimentary to a perfect state, and the connexion between them and the action of light, and had found that there was, apparently, a most remarkable correlation. When more and more developed under the influence of light, coloured compounds were found more and more easily decomposed by the action of light and air, when they were no longer parts of living plants, but dissolved out from them. There was thus, apparently, some condition in living plants which actually reversed these re-actions. He had also found that in the more rudimentary state of the leaves of the highest classes, the colouring matters corresponded with those found in lower classes, and in the case of the petals of flowers their more rudimentary condition often corresponded with some other variety, which thus appeared as if due to a naturally arrested development of a particular kind. This principle would, perhaps, serve to explain the greater prevalence of flowers of particular colours in tropical, or colder regions, and at different elevations. Mr. Sorby is about to extend his inquiries, to determine (what he at present only infers from the indications of his previous experiments) whether light, with a relatively greater amount of the blue rays, might not be relatively more favourable to the cryptogamia than to the flowering plants.—*Athenæum.*

THE USES OF BORAGE.

Borage is very abundant in the South of Europe, the Levant, and middle Asia. In the neighbourhood of Aleppo it grows so abundantly as to be quite a feature in the landscape; and, what renders it the more noticeable, the flowers there are larger and more intense in colour than with us. Its name is said to be taken from *cor* (heart) and *ago* (to affect)—an earnest of its cordial qualities—and some here advocate that we should spell it 'corago.' It is indigenous to England; its favourite localities are hillsides and waste places amongst rubbish. If the reader is going to the seaside next autumn, and should choose Southsea, let him one fine afternoon take the train to Cosham, walk up Portsdown Hill, and he may return home rich with borage for his cider-cup and copas. In the days of good Queen Bess both the leaves and flowers were eaten in salad, and the borage, with other herbs, was gathered for store, as well as for present use; the dried plant received its meed of praise, for it kept 'seeming and savour all the winter long.' I am told the young leaves form no bad substitute for spinach. Some old-fashioned people still use it with honey as a gargle; and in France it is occasionally given for rheumatism and skin diseases, with what success the writer knoweth not, and a green colour is made from the flowers. The leaves contain a considerable quantity of nitre, which may be proved by holding a bit of the dried plant in a flame. The burning will be accompanied by slight coruscation and detonation; hence the cooling properties of the plant. I will hazard an opinion that this is the secret of its curative effects in sore throat, &c. The root is employed in making rouge; the tissues of the plant contain gum, and may be used as a demulcent. Borage you see is, or might be, a very useful 'weed,' good for something else than cider-cup. To those who wish to Canaanise their 'four acres' we strongly recommend borage. The bees are particularly fond of it; around its blue blossom they love to congregate, and if they do not find it at home, are apt to wander in search thereof far and wide—many, alas! never to return; or if they do reach their quarters, die from fatigue on the very threshold of their hives. So all ye apiarians cultivate borage. With regard to its culture, that is not very difficult: the seeds should be sown nine inches apart, and the sowing may be in Spring or August.—*The Field.*

CLOVES.

This spice, above all others, is now attracting the greatest attention, and, as is usually the case, when prices of a commodity are advancing, speculators are taking the lead in purchasing all that sanguine holders can be induced to offer. There has within the last year or two been a great rise in the value of this article, and another material advance has recently occurred.

Increasing scarcity is said to be the cause of so extraordinary a movement, and it is feared that the statement is too well grounded for any attempt at refutation, either by figures or argument. Time was when the Dutch colonists in the East Indies, to protect the selfish interests of their commercial classes who traded between Holland and Batavia, and to acquire a grand monopoly of the trade in cloves, have been known to burn and destroy the crops in adjacent countries, saving only their own; but all such wretched barbarism has long since died out, and we have now to contend with disasters that are beyond human power to prevent. A hurricane in its fury will often lay waste and sweep away entire crops, which will take years to renew in the ordinary course of things; and while they are being replaced serious losses and inconveniences have to be borne by both speculators and consumers. Something of this sort is at present being experienced, and is traceable to the violent cyclone or hurricane that swept over Zanzibar in April 1872, which has been till now producing a marked effect on the selling price of cloves. The average crop in favourable seasons is very large, and, after sufficing for the wants of the surrounding country, there has generally been a liberal surplus remaining over for exportation to foreign parts, Europe taking by far the largest proportion. As the clove plant requires several years to mature, and the excessive stocks of crops previous to 1872 have been considerably worked down, the almost total failure of the supply in that year is at length making itself severely felt, and hence it is that the market here has become so extremely buoyant.—*Grocer.*

GIGANTIC FUNGUS FROM THE BANK OF ENGLAND.

Mr. Alfred Smee, M.R.C.S., found a huge fungus growing parasitically upon the pitch-pine joists of the Bank of England, in Threadneedle Street. The entire growth was so large that when packed in a box for transit it was as much as two strong men could carry. The largest piece was no less than 6ft. 3in. in circumference, 7in. thick, and weighed 32 lb., growing upon a piece of joist weighing 6½lb. When we first saw the box our thoughts wandered from "bulliard," to "bullion" and we were in hopes of a "Batsch" of Agaricus "aureus;" but the fungus turned out to be Polyporus annosus, Fr., a plant peculiar to the Coniferæ, and perhaps not uncommon in similar situations beneath floors, &c., as we have already recorded it from the coal mines of Wales. The mycelium had completely destroyed the wood of the pitch-pine joists, and in the decayed parts we found an abundant crop of young cockroaches, spiders, and mites. The fungus was shown at the Fungus Exhibition of the Royal Horticultural Society on the 1st of October.—*Gardeners' Chronicle.*

BEET-ROOT SUGAR.

The manufacture of Beet-root sugar artificially by M. Jouglet is exciting much interest in France. The chemical process by which this is effected is described as comparatively simple and very economical. The new sugar can be, it is said, produced at five francs per 100 kilogrammes; and M. Jouglet has sold his invention to a company, who intend to work it commercially.

EUCALYPTUS.

Dr. P. Marès has contributed a paper to the *Bulletin Mensuel* on the acclimatisation of various sorts of Eucalyptus in Algeria. The results of the experiments to produce different coloured silks go to show that silk-worms fed on cherry-leaf produce a bright chromo-yellow-coloured silk, those on pear-leaves a darker shade of the same colour, those on apple-leaves a nearly white silk, but coarser than that of the silk-worms fed on mulberry-leaves.

MUSHROOM POISONING.

Some useful advice on the subject of Mushrooms was given by Mr. Justice Denman in the Central Criminal Court, on the occasion of the Grand Jury throwing out a bill of indictment against a gardener who was charged with murdering a fellow-servant by giving her Poisonous Mushrooms to eat. Although there was no reason to suppose that the prisoner had any felonious intention in giving the deceased the mushrooms, yet three persons were dangerously poisoned by them, and one of them actually died; the fungi being so much like mushrooms that even a skilled witness saw nothing in them to distinguish them from those articles of food. Mr. Justice Denman thought it was desirable that these facts should be thoroughly well published and known. It appeared that mushrooms growing under trees were dangerous, because, as he (Mr. Justice Denman) supposed, they were fed on decayed roots which were, perhaps, tainted with poison. "That being so," added the Judge, "let everybody beware of eating mushrooms which grow under trees." So many persons have from time to time come to an untimely end through eating poisonous fungi bearing a close resemblance to mushrooms that perhaps the most prudent course would be for those who are unwilling to risk their lives to abstain from eating mushrooms altogether. In the meantime, however, as there are many people who infinitely prefer the chance of a painful death to the certain anguish of denying themselves any luxury on which they set their hearts, it may, perhaps, be as well to call attention to the following tabulation by Professor Bentley of the general characters by which the edible and poisonous species of fungi may, as a rule (but not an unerring one), be distinguished. Edible mushrooms :—1, Grow solitary, in dry airy places; 2, are

generally white or brownish; 3, have a compact brittle flesh; 4, do not change colour when cut, by the action of the air; 5, juice watery; 6, odour agreeable; 7, taste not bitter, acrid, salt, or astringent. Poisonous mushrooms:—1, Grow in clusters, in woods, and dark damp places; 2, usually with bright colours; 3, flesh tough, soft, and watery; 4, acquire a brown, green, or blue tint when cut and exposed to the air; 5, juice often milky; 6, odour commonly powerful and disagreeable; 7, having an acrid astringent, acid, salt, or bitter taste. It is best to avoid all fungi which have arrived at their full development or show any signs of change; and by soaking doubtful fungi cut in slices for about an hour in vinegar and afterwards washing them in boiling water, they may, it is stated, be rendered harmless.—*Pall Mall Gazette.*

THE POTATO DISEASE.

MESSRS. CHARLES WHITEHEAD, John Algernon Clarke, William Carruthers, and H. M. Jenkins, the judges appointed by the Royal Agricultural Society to examine the essays competing for the 100*l.* prize offered by Lord Cathcart for the best essay on "The Potato Disease and its Prevention," presented their Report at a late meeting of the Society's Council. Among 94 essays, not one has been found worthy of an award; in fact, had anybody really succeeded in combating the disease, he would probably have done better with his discovery than by describing the *modus operandi* for 100*l.* The causes most frequently set forth in the manuscripts were degeneration of the tuber, fungus on the tuber, superabundant moisture and wet weather, *Peronospera infestans* attacking the leaves and stems of the plant, electrical action, and unhealthy condition of the plant, induced by the use of certain manures. The principal remedies recommended were the cultivation of new varieties, use of disease-proof sorts, employment of lightning-conductors, application of lime as a manure, avoidance of specified manures, steeping or kiln-drying the tuber before planting, dressing the haulm with sulphur, chlorine, &c., cutting off the tops on the first appearance of disease, growing the potatoes in small clumps or hillocks, bending down the haulm so as not to drip over the roots, and tying up the haulm to stakes, or cultivating sorts having erect stalks. Evidence in some essays contradicted in nearly all cases alleged results stated in others. The judges have recommended the society to grant a handsome sum of money for the purpose of inducing some competent mycologist to undertake an investigation of the life-history of the potato fungus (*Peronospera infestans*) in the interval between the injury to the potato plant and the reappearance of the fungus in the following year. Also that valuable prizes should be offered for the best disease-proof early and late potatoes, the awards to be made after testing the competing sorts and their produce during three seasons.—*Times.*

VINTAGE OF 1873.

The grape harvest in France promised to be unusually fine last year. How large a share the vineyards take in the produce of the country, and to what an extent they form the wealth of all classes, we may judge from the fact that there are 2,300,000 vineyard proprietors in the Republic. In all the sunny land of France there are only 11 Departments which do not grow the vine; 20 cultivate the grape for home consumption, and 58 for export. Most of the fruit is intended for the wine presses; but the best dessert grapes also come from France. The famous Chasselas of Fontainebleau are grown in the two little townships of Thomery and Champagne, both in the neighbourhood of Fontainebleau. The vineyards there produce an annual crop of about 2,000,000 lbs., of which the capital consumes about 800,000 kilogrammes; while the rest is exported to England, Austria, and even Russia. The trade in grapes, foreign and home grown, amounts in value to several million francs a year. This, of course, does not include grapes used for wine.—*Globe.*

ST. MICHAEL'S ORANGES.

The British Consul at St. Michael's has sent to the Foreign Office, in a recent Report, an account of the value of the fruit trade of that island with Great Britain, year by year, from the year 1747, when it commenced, down to 1872. The first export of oranges thence to this country is recorded in 1751, when 3½ boxes, at 900 reis per box, amounting in all to little more than 3 milreis, were sent. The trade grew and multiplied, and 120 years afterwards, in 1871, the export comprised 264,925 boxes, at 1,610 reis per box, or 426,932 milreis in all. In 1872 the Consul's returns show that there were 256,451 boxes of oranges exported from St. Michael's; their value was 80,705*l.*, and the export duty produced 599*l.* Pine-apples and bananas are also cultivated. Our own Custom-house returns state that in 1872 we received from the Azores oranges and lemons of the value of 329,342*l.* But though Great Britain absorbs almost the whole of the foreign trade of the Azores, and imposes no duty upon the import of their fruit, these islands treat us with scant courtesy; for whilst France and Prussia are allowed an invidious exception in favour of their merchandise, an additional *ad valorem* duty is imposed upon British wares exclusively. Owing to this heavy duty French goods, which are favoured, are to be purchased at lower rates. The Consul has to state that tourists should be advised to visit St. Michael's in July and August only. The climate has been described as a nine months' rainy spring, and as a winter station St. Michael's is, as compared with Madeira, deficient in the comforts of life, and has not an enviable climate.

EFFECTS OF FOG UPON PLANTS.

The fog of the winter of 1873 left the vegetable world less distinctly and less hurtfully than on the higher organisms, but sufficient to be recognised beyond the possibility of mistake. In some cases the effect of the fog was at once evident, in others it was slowly manifested, and only now are we enabled fully to determine the nature of the mischief wrought in the case of several families of plants that are in a comparatively dormant state at this season. The most striking and the most rapid effect of the fog was seen in the orchid house. Scarcely had the darkness cleared away than the orchids, which were finely in flower before the fog came, were found to be flowerless, flabby, and deficient of healthy greenness in their leaves. As for the flowers, they were on the floor, and in many instances so far mildewed and soiled as not to be worth picking up. When a few days had elapsed, the camellias, which had been densely covered with swelling buds, began to shake them off, and in large houses the old trees shed their buds so that they fell like a shower of green hailstones. Fortunately, camellias were generally in good case when the fog came, and it has not completely stripped them. Since the bright, clear frost set in, the pelargoniums have been behaving badly, the more delicate variegated-leaved varieties having cast their full-grown leaves profusely; just as they do at any season of the year if they take cold suddenly. The virulent nature of the fog was soon declared by the state of the glass of plant houses; for when it cleared away the light was perceptibly dimmed by a greasy deposit which rain refused to cleanse away, and therefore the unusual practice of scrubbing and rubbing the outside of the glass was resorted to in many well-kept gardens. The hollies appear to be indifferent to fog, for they still look delightfully bright, and have not cast their berries. But the thorns and wild roses felt it, and the great crop of coral berries they carried lies for the most part on the ground beneath them. The pyracanthas are scarcely the worse for it, and their glorious berries will make amends to the thrushes for the scattering of the hips and haws.—*Gardeners' Magazine.*

A DISEASE-DESTROYING TREE.

M. Gimbert, who has long been engaged in collecting evidence concerning the Australian tree "Eucalyptus globulus," the growth of which is surprisingly rapid, attaining besides gigantic dimensions, has addressed an interesting communication to the Academy of Sciences. This plant, it now appears, possesses an extraordinary power of destroying miasmatic influence in fever-stricken districts. It has the singular property of absorbing ten times its weight of water from the soil, and of emitting antiseptic camphorous effluvia. When sown in marshy ground it will dry it up in a very short time. The English

were the first to try it at the Cape, and within two or three years they completely changed the climatic condition of the unhealthy parts of the colony. A few years later its plantation was undertaken on a large scale in various parts of Algeria. At Pardock, 20 miles from Algiers, a farm situated on the banks of the Hamyze was noted for its extremely pestilential air. In the Spring of 1867 about 1,300 of the eucalyptus were planted there. In July of the same year—the time when the fever season used to set in—not a single case occurred, yet the trees were not more than nine feet high. Since then complete immunity from fever has been maintained. In the neighbourhood of Constantine the farm of Ben Machydlin was equally in bad repute. It was covered with marshes both in winter and summer. In five years the whole ground was dried up by 14,000 of these trees, and farmers and children enjoy excellent health. At the factory of the Gue de Constantine, in three years a plantation of eucalyptus has transformed twelve acres of marshy soil into a magnificent park, whence fever has completely disappeared. In the island of Cuba this and all other paludal diseases are fast disappearing from all the unhealthy districts where this tree has been introduced. A station-house at one of the ends of a railway viaduct in the Department of the Var was so pestilential that the officials could not be kept there longer than a year. Forty of these trees were planted, and it is now as healthy as any other place on the line. We have no information as to whether this beneficent tree will grow in other but hot climates. We hope that experiments will be made to determine this point. It would be a good thing to introduce it on the West Coast of Africa.—*Homeward Mail.*

THE BLUE GUM TREE.

MR. J. HENRY ROGERS writes to us from Green Hedges, East Grinstead, Sussex:—"As many somewhat vague statements respecting the hardiness of the blue Gum Tree and its influence over malarious diseases have lately appeared, the following facts may be considered worthy of being made known. I have at present growing in front of the cottage in which I reside, close to, but not nailed to, the west wall, several blue gum trees. No. 1, planted in the Spring of 1871, has survived two winters without protection; at 6 ft. from the ground it has a circumference of 7 in. Its height at present is only 15 ft., the upper portion having been torn off by wind. No. 2, planted in the Spring of 1872, has survived one winter, also without protection of any kind. Its circumference, at 6 ft. from the ground, is 5½ in., and its height 18ft. No. 3, planted in the Spring of last year, has attained a height of 14½ ft. All these trees, and several smaller specimens of the same, and nearly allied species, are at this present time in perfect health and vigour, and are quite uninjured by frost. That this tree is capable of resisting

the cold of ordinary winters in sheltered situations of the south of England cannot be doubted, even when planted, as my specimens are, on a retentive clay. As regards its influence over diseases arising from malaria, I may mention that since the winter of 1850–51, when I had a very severe attack of malaria fever in Rome, I have been liable, especially in the autumn, to irregular anguish symptoms, but since my gum-trees have grown sufficiently tall to beat against the casement of my bed-room windows, I have not had any return of my very disagreeable sensations. A solitary case like this is, of course, open to various explanations and objections; but the fact remains."

THE ROSE CROP.

VICE-CONSUL DUPUIS reports that the Rose harvest of 1873 in the villages of Adrianople has on the whole been renumerative to cultivators, and the crop is said to yield about 500,000 miscals, or about 93,750 ounces of otto or attar of rose, and is valued at about 70,000*l.*; but, owing to the moist weather, distillation was profuse, and the product is consequently less strong than in 1872. According to the degree of dryness of the season it takes from 8 to 9 okes (23 to 24 lb.) to 14 to 16 okes (38 to 44 lb.) of the blossoms to produce one miscal of oil; and the price ranges, according to quality, from 14 to 18 piastres the miscal, or from 13*s.* 1*d.* to 16*s.* 10*d.* per ounce. The mode adopted for testing the purity of the different qualities of these oils is to put the essence into flasks, which are afterwards immersed in water at a temperature of 63 to 68 deg. Fahrenheit; if the quality be good, it will freeze, and this oil is preferred to all others as being of the purest kind. Some inferior oils will not freeze even at 52 deg. The oils from various soils differ greatly in quality, and manufacturers frequently adulterate the oils by an admixture of a substance produced by them from certain kinds of grasses. Otto of rose is mostly exported from Adrianople to Germany; buyers from that country annually resort to Adrianople, and make purchases to the amount of about 62,000 ounces, the remainder finding ready markets in Constantinople and the East.

OZONE IN FORESTS.

M. EBERMAYER has been examining the influence of forests on the ozone-contents of the air; he states there is more ozone in and near forests than in the open, but among the denser branches there is somewhat less than in the open closely bordering the forest, and in the tops of the trees there is more than in the lower parts.

Geology and Mineralogy.

PROGRESS OF GEOLOGY.

Professor John Phillips, F.R.S., President of the Geological Section of the British Association, in his address, remarks "that the natural sciences in general, and geology in particular, have derived from the British Association some, at least, of the advantages so boldly claimed at its origin. Some impediments have been removed from their path, and the results of these discoveries are written in the prosperous annals of our native country.

"Turning from topics which involve industrial interests to other lines of geological research, we remark how firmly, since 1831, the great facts of rock-stratification, succession of life, earth-movement, and changes of oceanic areas, have been established and reduced to laws—laws, indeed, of phenomena at present, but gradually acquiring the character of laws of causation.

"Among the important discoveries by which our knowledge of the earth's structure and history has been greatly enlarged within forty years, place must be given to the results of the labours of Sedgwick and Murchison, who established the Cambro-Silurian systems, and thus penetrated into ancient time-relics very far toward the shadowy limit of palæontological research. Stimulated by this success, the early strata of the globe have been explored with unremitting industry in every corner of the earth; and thus the classification and the nomenclature which were suggested in Wales and Cumberland are found to be applicable in Russia and India, America and Australia, so as to serve as a basis for the general scale of geological time, founded on organic remains of the successive ages.

"This great principle, the gift of William Smith, is also employed with success in a fuller study of the deposits which stand among the latest in our history and involve a vast variety of phenomena, touching a long succession of life on the land, changes of depth in the sea, and alterations of climate. Among these evidences of physical revolution, which, if modern as geological events, are very ancient if estimated in centuries, the earliest monuments of men find place—not buildings, not inhabited caves or dwellings in dry earth-pits, not pottery or fabricated metal, but mere stones shaped in rude fashion to constitute apparently the one tool and one weapon with which, according to Prestwich, and Evans, and Lubbock, the poor inhabitant of northern climes had to sustain and defend his life.

"Nothing in my day has had such a decided influence on the

public mind in favour of geological research, nothing has so clearly brought out the purpose and scope of our science, as these two great lines of inquiry, one directed to the beginning, the other to the end of the accessible scale of earthly time; for thus has it been made clear that our purpose can be nothing less than to discover the history of the land, sea, and air, and the long sequence of life, and to marshal the results in a settled chronology—not, indeed, a scale of years to be measured by the rotations or revolutions of planets, but a series of ages slowly succeeding one another through an immensity of time.

"There is no question of the truth of this history. The facts observed are found in variable combinations from time to time, and the interpretations of these facts are modified in different directions; but the facts are all natural phenomena, and the interpretations are all derived from the real laws of these phenomena—some certified by mathematical and mechanical research, others based on chemical discovery, others due to the scalpel of the anatomist, or the microscopic scrutiny of the botanist. The grandest of early geological phenomena have their representatives, however feeble, in the changes which are now happening around us; the forms of ancient life most surprising by their magnitude or singular adaptations can be explained by analogous though often rare and abnormal productions of to-day. Biology is the contemporary index of palæontology, just as the events of the nineteenth century furnish explanations of the course of human history in the older times. . . .

"During the long course of geological time the climates of the earth have changed. In many regions evidence of such change is furnished by the forms of contemporary life. Warm climates have had their influence on the land, and favoured the growth of abundant vegetations as far north as within the arctic circle; the sea has nourished reef-making corals in northern Europe during Palæozoic and Mesozoic ages; crocodiles and turtles were swimming round the coasts of Britain, among islands clothed with Zamiæ and haunted by marsupial quadrupeds. How have we lost this primeval warmth? Does the earth contribute less heat from its interior stores? does the atmosphere obstruct more of the solar rays or permit more free radiation from the land and sea? has the sun lost through immensity of time a sensible portion of its beneficent influence? or, finally, is it only a question of the elevation of mountains, the oceanic currents, and the distribution of land and sea?

"The problems thus suggested are not of easy solution, though in each branch of the subject some real progress is made. The globe is slowly changing its dimensions by cooling; thus inequalities and movements of magnitude have arisen and are still in progress on its surface. The effect of internal pressure, when not resulting in mass-movement, is expressed in the molecular action of heat which Mallet applies to the theory of volcanoes.

The sun has no recuperative auxiliary known to Thomson for replacing his decaying radiation; the earth, under his influence, as was shown by Herschel and Adhemar, is subject to periods of greater and less warmth, alternately in the two hemispheres and generally over the whole surface; and finally, as Hopkins has shown, by change of local physical conditions the climate of northern zones might be greatly cooled in some regions and greatly warmed in others.

"One is almost frozen to silence in presence of the vast sheets of ice which some of my friends (followers of Agassiz) believe themselves to have traced over the mountains and vales of a great part of the United Kingdom, as well as over the kindred regions of Scandinavia. One shudders at the thought of the innumerable icebergs with their loads of rock, which floated in the once deeper North Sea, and above the hills of the three Ridings of Yorkshire, and lifted countless blocks of Silurian stone from lower levels, to rest on the precipitous limestones round the sources of the Ribble.

"Those who with Professor Ramsay adopt the glacial hypothesis in its full extent, and are familiar with the descent of ice in Alpine valleys, where it grinds and polishes the hardest rocks, and winds like a slow river round projecting cliffs, are easily conducted to the further thought that such valleys have been excavated by such ice-rubbers, and that even great lakes on the course of the rivers have been dug out by ancient glaciers which once extended far beyond their actual limits. That they did so extend is in several instances well ascertained and proved; that they did in the manner suggested plough out the valleys and lakes is a pre_ ation which cannot be accepted until we possess more knowledge than has yet been attained regarding the resistance offered by ice to a crushing force, its tensible strength, the measure of its resistance to shearing, and other data required for a just estimate of the problem. At present it would appear that under a column of his own substance 1,000ft. high, ice would not retain its solidity; if so, it could not propagate a greater pressure in any direction. This question of the excavating effect of glaciers is distinctly a mechanical problem, requiring a knowledge of certain data; and till these are supplied, calculations and conjectures are equally vain.

"A distinguishing feature of modern geology is the greatest development of the doctrine that the earth contains in its burial-vaults, in chronological order, forms of life characteristic of the several successive periods when stratified rocks were deposited in the sea. This idea has been so thoroughly worked upon in all countries, that we are warranted* to believe in something like one universal order of appearance in time, not only of large groups but even of many genera and species. The Trilobitic ages, the Ammonitic, Megalosaurian, and Palæotherian periods, are familiar to every geologist. What closed the career of the several races of plants and animals on the land and in the sea,

is a question easily answered for particular parts of the earth's surface by reference to "physical change;" for this is a main cause of the presence or absence, and in general of the unequal distribution of life. But what brought the succession of different races in something like a constant order, not in one tract only, but one may say generally in oceanic areas, over a large portion of the globe?

"Life unfolds itself in every living thing, from an obscure, often undistinguishable cell germ, in which resides a potential of both physical and organic change—a change which, whether continual or interrupted, gradual or critical, culminates in the production of similar germs, capable under favourable conditions of assuming the energy of life.

"How true to their prototypes are all the forms with which we are familiar, how correctly they follow the family pattern for centuries, and even thousands of years, is known to all students of ancient art and explorers of ancient catacombs. But much more than this is known. Very small differences separate the elephant of India from the mammoth of Yorkshire, the *Waldheimia* of the Australian shore from the *Terebratula* of the Cotswold oolite, the dragon-fly of our rivers from the *Libellula* of the Lias, and even the *Rhynchonellæ* and *Lingulæ* of the modern sea from the old species which swarm in the Palæozoic rocks.

"But concurrently with this apparent perpetuity of similar forms and ways of life, another general idea comes into notice. No two plants are more than alike; no two men have more than the family resemblance; the offspring is not in all respects an exact copy of the parent. A general reference to some earlier type, accompanied by special diversity in every case ("descent with modification"), is recognised in the case of every living being.

"Similitude, not identity, is the effect of natural agencies in the continuation of life-forms, the small differences from identity being due to limited physical conditions, in harmony with the general law that organic structures are adapted to the exigencies of being. Moreover, the structures are adaptable to new conditions; if the conditions change, the structure changes also, but not suddenly; the plant or animal may survive in presence of slowly altered circumstances, but must perish under critical inversions. These adaptations, so necessary to the preservation of a race, are they restricted within narrow limits? or is it possible that in course of long-enduring time, step by step and grain by grain, one form of life can be changed and has been changed to another, and adapted to fulfil quite different functions? Is it thus that the innumerable forms of plants and animals have been 'developed' in the course of ages upon ages from a few original types?

"This question of development might be safely left to the prudent researches of Physiology and Anatomy, were it not the

case that palæontology furnishes a vast range of evidence on the real succession in time of organic structures, which on the whole indicate more and more variety and adaptation, and in certain aspects a growing advance in the energies of life. Thus at first only invertebrate animals appear in the catalogues of the inhabitants of the sea, then fishes are added, and reptiles and the higher vertebrata succeed; man comes at last, to contemplate and in some degree to govern the whole.

"The various hypothetical threads by which many good naturalists hope to unite the countless facts of biological change into an harmonious system have culminated in Darwinism, which takes for its basis the facts already stated, and proposes to explain the analogies of organic structure by reference to a common origin, and their differences to small, mostly congenital, modifications which are integrated in particular directions by external physical conditions, involving a 'struggle for existence.' Geology is interested in the question of development, and in the particular exposition of it by the great naturalist whose name it bears, because it alone possesses the history of the development *in time*, and it is to inconceivably long periods of time, and to the accumulated effect of small but almost infinitely numerous changes in certain directions, that the full effect of the transformations is attributed.

"For us, therefore, at present it is to collect with fidelity the evidence which our researches must certainly yield, to trace the relation of forms to time generally and physical conditions locally, to determine the life-periods of species, genera, and families in different regions, to consider the cases of temporary interruption and occasional recurrence of races, and how far by uniting the results obtained in different regions the alleged 'imperfection of the geological record' can be remedied.

"The share which the British Association has taken in this great work of actually reconstructing the broken forms of ancient life, of repeopling the old land and older sea, of mentally reviving, one may almost say, the long-forgotten past, is considerable, and might with advantage be increased. We ask, and wisely, from time to time, for the combined labour of naturalists and geologists in the preparation of Reports on particular classes or families of fossil plants and animals, their true structure and affinities, and their distribution in geological time and geographical space. Some examples of this useful work will, I hope, be presented to this meeting. Thus have we obtained the aid of Agassiz and Owen, and have welcomed the labours of Forbes and Morris, and Lycett, and Huxley, of Dawkins and Egerton, of Davidson, Duncan, and Wright, of Williamson and Carruthers and Woodward, and many other eminent persons, whose valuable results have for the most part appeared in other volumes than our own.

"Among these volumes let me in a special manner recall to your attention the priceless gift to Geology which is annually

offered by the Palæontograpoical Society, a gift which might become even richer than it is, if the literary and scientific part of our community were fortunate enough to know what a perpetual treasure they might possess in return for a small annual tribute."

PREHISTORIC ARCHÆOLOGY.

Mr. Pengelly has communicated to the British Association a memoir "On the Flint and Chert Implements found in Kent's Cavern, Torquay." The story of Kent's Hole has so often been told that we need do no more than barely refer to it. How it got its name nobody seems to know. As far back as 1825 its scientific exploration was commenced by the Rev. Mr. MacEnery, and the work has since been carried on by numerous explorers. No name, however, has been more intimately identified with these researches than that of Pengelly. For seven-and-twenty years Mr. Pengelly has been more or less actively engaged in the work, and has of late years personally superintended the investigations of the Committee appointed by the British Association in 1864, and still active in the systematic exploration of this remarkable cavern. In studying the deposits in Kent's Hole, a definite sequence may be observed, and the object of the present paper was to show that the works of man detected in two of these deposits, occupying different horizons, varied considerably in their characters; those from the lower deposit being much fewer in number and ruder in form than those from the upper, and therefore more recent, stratum. The principal implements found in the so-called "cave-earth" are ovoid, lanceolate, or tongue-shaped, and are fashioned from flint-flakes. Associated with these stone implements have been found several bone-harpoons, a bone-needle, a bone-pin, and a bone-awl. From the nethermost deposit, known as the "breccia," but few implements have been obtained, and these are of much more primitive type than those of the cave-earth. They are formed from natural flint nodules, and not from artificially-formed flint-flakes. Moreover, no bone implements have yet been found in the breccia. Indeed, the whole of the evidence points to the breccia as representing a much less advanced period of civilisation than that indicated by the overlying cave-earth, and there seems good reason to believe that the two deposits were separated by an interval of great duration.

COAL AND COAL PLANTS.

Professor W. C. Williamson has addressed to the British Association a Lecture on Coal and Coal Plants. After a few introductory observations, the Professor remarked: "When he remembered how short was the time since Professor Huxley had addressed a Bradford audience on the subject of coal, he was somewhat appalled at his own boldness in having ventured to

deal with a similar matter at the present moment. But luckily for him science did not stand still, and although so short a time had elapsed since Professor Huxley had delivered the lecture referred to, there was much now to be said on the subject which could not have been said then. Still, with the magnificent address of Professor Huxley within reach, it would not be necessary to detain the auditory long on the general theories which were now so widely accepted with reference to the origin of coal.

Professor Phillips, in his address to the Geological Section on the previous morning, had reminded them how short a time it was—the period being within his own life-time—since the vegetable origin of coal was broadly and openly disputed. It would, however, be difficult now to find anyone at all enlightened on the subject who would venture to dispute that the origin of coal was vegetable. In the same way another hypothesis—known by the title of the drift theory—had once been very generally accepted. Men who admitted the conclusion that coal had once been a mass of vegetable life differed as to the method by which that vegetable mass had found its way into its present position. The majority of the older geologists believed that coal had been conveyed into those positions by water—that large quantities of vegetable material had been brought down great rivers like the Mississippi or the Ganges, that these vegetable rafts, as they might be termed, had accumulated in the estuaries and the ocean, and that when they had become thoroughly water-logged, they had sunk to the bottom and formed accumulations of vegetable elements sufficient to constitute the existing coal-beds. Thanks to the labours of a series of indefatigable workers like the late Mr. Bowman, Mr. Binney, Sir Wm. Logan, and others, we now had a clearer and much more probable conception as to what coal originally was.

It must be understood that although the earth was popularly regarded as the type of everything that was stable and immovable, this was a very erroneous idea; for old mother earth was about one of the most fickle and inconstant of all the jades with which men had to deal. She was never still. It happened that at the present day there were certain regions, such as the volcanic regions, which were always moving upwards, like the more aspiring of the youths of Bradford, while there were others, such as the coral regions, which were steadily going downward, like those less fortunate youths who did not succeed in the race of life. So it had been in the olden time. The coal beds appeared to have accumulated in the latter class of areas—the areas of depression—geographical areas in which the earth had a tendency to sink below the level of the ocean. Upon such areas mud and silt had accumulated until the deposit thus formed had reached the level of the water, and then came what would appear to have been highly necessary as a preliminary to the growth of the coal material, namely, a bed of blue mud. It was not known why that blue mud was there or whence it came, but it was as

certain as that garden plants required favourable soils for their development, that whatever its cause the blue mud was the soil which seemed to have been preferred by the great majority of the plants constituting the forests of the carboniferous era. In it the minute spores or seeds of the vegetables which afterwards became coal, germinated and struck root, until eventually the muddy soil became converted into a magnificent and almost tropical forest. As the forest grew the spores fell from the trees, the half-dead leaves and decayed branches also dropped, and by-and-by the stems themselves gave way, and thus was accumulated an immense amount of vegetable matter. This, in the progress of time, sank below the water level, and more mud being deposited on the top of the coal, the new formation in turn underwent the same processes as its predecessors, until at length a new forest was formed to share the same fate as that which had gone before it. The process was repeated again and again, until at length we had an accumulation of materials, mixtures of the various substances he had spoken of, alternating with beds of coal, until we had a vertical thickness of rock varying from three, four, or five, to as much as eight or ten thousand feet.

But while these general truths were accepted with little or no reservation, there were one or two points contained in Prof. Huxley's lecture upon which he would venture for a moment to dwell. In that lecture he properly laid stress upon certain minute bodies that were found in the interior of coal.

[The lecturer here pointed to a diagram representing a vertical section of coal, and he also exhibited various pieces of coal, one of which he held in the position it occupied in the coal-bed, Another diagram, he said, represented a quantity of black coaly matter arranged in layers, and embedded in this matter were some small bodies which had been flattened by the pressure of the coal, and by the superimposed beds between the coal.]

Prof. Huxley spoke of these bodies under the name of sporangia, or spore-cases. Now, he (Prof. Williamson) had come to the conclusion that they were all spores of all classes—the larger ones called macro-spores, and the smaller ones micro-spores. A large number of the plants, if not all, found in the coal-measures belonged to the cryptogamic plants, in which was found no trace of seed or flowers. The reproductive bodies that took the place of seed were little bud-like structures, to which the name of spores was given. In a certain class of those plants, the club-mosses, for instance, were two kinds of these spores. The sporangia of club mosses and similar plants never became detached from their parent stem. They burst and liberated multitudes of contained spores, which were objects like those so abundant in many coals. But these spores did not play so important a part in the formation of coal as Prof. Huxley supposed. On examining these objects it was found that each of the little rounded discs exhibited three ridges that radiated in a

triangular manner from a common centre. These discs were originally masses of protoplasm, lodged within a mother-cell. By-and-by each of these masses broke up into three or four parts; and it was found that to accommodate one another in the interior of their circular chamber, they mutually pressed one another. To illustrate the mutual compression, Prof. Williamson produced a turnip, which he had cut into four parts, that corresponded exactly, he said, in their arrangement with the arrangement of the four spores in the interior of the mother cell.

Then Prof. Huxley held that coal consisted of two elements. Prof. Williamson, exhibiting again a piece of coal, said the dirty blackening surface was a thin layer of little fragments of woody structures, vegetable tissues of various kinds, known by the name of mineral charcoal. These layers of mineral charcoal were exceedingly numerous. Prof. Huxley, recognising the abundance and significance of these little spore-like bodies, thought that mineral charcoal formed only a portion, and a limited portion, while the great bulk of black coaly matter was really a mass of carbon derived from chemically altered spores. He thought that on this point they would be obliged somewhat to differ from Prof. Huxley.

The bed which had been most widely quoted as containing most beautiful spores was found in the district of Bradford. If everything decayed, and Bradford was by an exceedingly improbable combination of circumstances to pass out of memory, it would be remembered in scientific history as the locality in which the "better bed" was found. The fragment he held in his hand was a fragment of the better bed. On examining it for a moment through a magnifying glass he saw that it was a solid mass of mineral charcoal, yet the microscope revealed in it no trace whatever of organic structure. Therefore, while Prof. Huxley divided coal into two elements—mineral charcoal and coal proper, including in the latter term altered spores—he would say that coal consisted of three elements—mineral charcoal, black coal derived from mineral charcoal, and spores.

This outline of the history of coal led them to the independent conclusion that two elements were mingled in coal: the vegetable *débris*, or broken up fragments of the plants of the carboniferous age, were intermingled with the peculiar spores to which Professor Huxley had so properly called attention. In proceeding to deal further with the plants of which coal was formed, the lecturer took occasion to acknowledge with thanks the loan of certain valuable specimens to illustrate his discourse from the Bradford Museum. One of these specimens was a most rare and valuable specimen, which he would be glad to take away with him to Owens College, if he had the chance; but he was afraid the Bradford people were too Conservative to stand that.

After giving a number of botanical and other details with

regard to the plants of which coal was formed, he said our knowledge of this subject resolved itself into two divisions, viz. that of the outward forms of plants and that of their inward organisation. These two lines of inquiry did not always run parallel, and the one great object of recent research had been to make them do so. Specimens throwing light on the subject had been found at Arran, Burntisland, Oldham, Halifax, Autan in France, and elsewhere, and upon these a host of observers had been and still were working. It has long been known that most, if not all, the coal plants belonged to two classes, known as the Cryptogamia, or flowerless plants, and the gymnospermous exogens, represented by the pines and firs. All recent inquiries added fresh strength to this conclusion. One of the most important of these groups was that of the Equiseta or horse-tails, and which were represented in the coal by the Calamites. The long cylindrical stems, with their transverse joints and longitudinal grooves, were shown to be casts of mud or sand, occupying the hollows in the piths of the living plants. Each of these piths was surrounded by a thick zone of wood, which again was invested by an equally thick layer of bark. Specimens were shown in which, though the pith was only an inch in diameter, the wood and bark combined formed a cylinder 4 in. thick, giving a circumference of at least 27 in. to the living stem. But there exist examples of the pith casts alone, which are between 2 and 3 ft. in diameter. It was evident, therefore, he concluded, that the Calamites became true forest trees, very different from their living representatives—the horse-tail of our ponds and marshes.

After describing the organisation of these plants, the Professor proceeded to describe the Lycopods of the coal measures as represented by the Lepidodendra, Sigillariæ, and a host of other well-known plants. The living Lycopods, whether seen at home or in tropical forests, are dwarf herbaceous plants, but in the carboniferous age they become lofty forest trees, 100 ft. high, and 10 or 12 ft. in circumference. To enable such lofty stems, with their dense mass of serial branches and foliage, to obtain nutrition, an organisation was given to them approaching more nearly to that of our living forest trees than to that of any recent cryptogams. A succession of woody layers was added to the exterior of those previously existing; so that as the plant rose into the air the stem became strengthened by these successive additions to the vascular tissue. As this process advanced it was accompanied by other changes, producing a large central pith, and two independent vascular rings immediately surrounding the pith, and the relation of these various parts to the roots and leaves, as well as to the nutrition of the plants, was pointed out. The fruits of these Lycopods were then examined. The existence of two classes of spores corresponding in functions to the stamens and pistils of flowering plants, was dwelt upon, and one of these classes (the macrospores) was shown to be so similar

to the small objects found in coal, as to leave no doubt that those objects were derived from the lepidodendroid and sigillarian trees which constituted the large portion of the forest vegetation.

Certain plants known as Asterophyllites were next examined. The ferns were also reviewed, and shown to be as remarkable for the absence of exogenous growth from their stems as the Calamites and Lycopods were for its conspicuous presence. The structure of some stems supposed to represent palms was shown to be that of a fern, their being no true evidence that palms existed in that age. The plants known as coniferous plants, allied to pines and firs, were described, and their peculiar fruits, so common at Peel, in Lancashire, were explained, and some plants of unknown affinities, but beautiful organisation, were referred to. The physiological differences between these extinct ferns and other plants, especially in their marvellous *quasi*-exogenous organisation, was pointed out; and the lecturer concluded by showing how unvarying must have been the green hue of the carboniferous forests, owing to the entire absence from them of all the gay colours of the flowering plants which form so conspicuous a feature in the modern landscape, especially in the temperate and colder regions. The antiquity of the mummy, he added, was as nothing compared with the countless ages that had rolled by since these plants lived, and yet they must not forget that every one of those plants, living in ages so incalculably remote, had a history, an individuality as distinct and definite as our own. They would probably be inclined to ask the question, When did all these things take place? Echo answered, When?

DISTRIBUTION OF COAL IN CHINA.

The abstract just quoted was by far the most important communication, and, in fact, may be considered as the most weighty contribution to physical geography, brought forward at the Bradford meeting. The author. Baron von Richthofen, one of the distinguished foreign *savants* invited to Bradford, has devoted several years to the investigation of the geology, products, and resources of the interior provinces of China, and has traversed the whole country, with the exception of the south-western portions. He stated, as the result of his researches, that China exhibits the great peculiarity of containing no geological formation later than the Triassic; all the great secondary deposits from the lias to the chalk, and all the tertiary series, being absent. It has, therefore, been dry land throughout the whole period of these later formations; and to this peculiarity are owing the stupendous results of sub-aerial denudation which it furnishes; among which are the deep narrow gorges which its rivers have eroded nearly up to their sources, the rarity of cataracts and rapids, and the removal of rocks overlying the

great coal-beds. The coal strata belonged to various geological epochs, from the Silurian upwards; but by far the greater portion belonged to the same formation as the coal of Europe and North America, viz. the Carboniferous. The coal-beds were deposited around mountains of metamorphic and primary rocks which then constituted the land, and have lain horizontally, with little disturbance, ever since that remote epoch. The deep ravines worn by the rivers cut through these coal-bearing strata, and lay them bare on the precipitous sides; so that the coal is easily accessible on the banks of the great streams. The author proceeded to describe the extent of the coal in each province, beginning with Southern Manchuria and terminating with Honan. In Manchuria the coal is confined to valleys in the hilly parts, and is not readily accessible to foreign commerce; it is accompanied, however, by an abundance of rich iron ore, which at some future date will be worked with immense advantage to the country. Coal exists further west all along the great wall; and there are beds 95 feet thick near Pekin, in which city it is the fuel in universal use; but it is an error to suppose, as some have done, that the high hills round Pekin consist of coal-measures; coal is found only in limited valleys at a great elevation. The coal of Shantung, although not situated near good harbours, is the most accessible of all Chinese coal from the sea. It exists also in the other maritime provinces, but in districts offering much fewer facilities. The greatest of all the coal districts is in the west and north-west; at the southern foot of the great mountain range (the eastern continuation of the Kuen Lun), which here stretches across Western China. In Sze-chuen coal occupies an area of 100,000 square miles. At the centre of this vast basin the coal is bad and inaccessible, but round its borders it is of excellent quality, and near means of communication by water, although too distant from the sea to be available to foreigners. The whole surface of northern China is covered by rich yellow earth, or *læss*, to a depth often of 1,000 and 2,000 feet, which overlies all the coal-fields. The great plain of China is bordered on the west by a vast limestone wall, 2,000 to 3,000 feet high, on the top of which extends a plateau of coal in a state of excellent preservation, owing to its capping of hard limestone, which had resisted denudation. There are here 30,000 square miles of coal-bearing ground of the very best quality, in which the coal-beds lie perfectly horizontal, 30 feet thick, for a length of 200 miles. They extend westward into Shensi and Kansu, and are reported by all travellers to continue beyond the frontier of China far into Mongolia. Coal costs here, at the pit mouth, 7*d*. per ton, and the wages of miners are 6*d*. per day. The Baron believed that the readiest way of getting at this vast coal-field from Europe was by a railway from Ili and Kulja, in Russian territory, to the north-western corner of Kansu.—*Times*.

THE MINING RECORDS.

The Mining Record Office is in intimate connexion with the Geological Survey of Great Britain, the Museum of Practical Geology, the Royal School of Mines, and has its seat in the same building, at 28 Jermyn Street. A large collection of plans is deposited in the building, and may be consulted by those who are interested in the mineral productions of the United Kingdom. But the office at the head of which is Mr. Robert Hunt, F.R.S., with Mr. Richard Meade and Mr. J. B. Jordan next in official rank, comes most prominently before the public in a literary way by annually publishing the useful *Mineral Statistics.*

In addition to the great staples of our trade, we have the china clay or kaolin and china stone, 1.200,000 tons of which, worth 450,000*l.*, were produced in 1872 for home use and for exportation, among other places to Copenhagen, Bremen, Brussels, and Cartagena. It may be new to many to hear of collieries in Ireland, producing, in 1872, 103,465 tons, in addition to mines of iron and other metals which are there. A million tons of rock and white salt were sent down the river Weaver in Cheshire, and Worcestershire raised 300.000 tons more. Ireland (Belfast Mining Company) contributed 20,000 tons, 3.000 tons of which were sent to Denmark. We shipped to British India 240,000 tons for 172,000*l.*, and smaller but considerable quantities were exported to Russia, the United States, and British North America.

Altogether, these Records will be found most useful by all interested in those mineral productions of Great Britain which have hitherto been the safe substructure of her commerce. It contains, as an appendix, a complete directory of the mines, collieries, the smelting and principal clay works of the United Kingdom, and the statistics are interesting in recalling the subsidiary resources which we possess.

NEW COAL FIELDS.

In the southern part of the Midland Coal field, the largest in England, and extending from Leeds to Nottingham, the greatest activity prevails in opening out several very large coal fields. On the estate of the Duke of St. Albans, at Beestwood-park, and adjoining Butwell Forest, shafts are being sunk to the "tophard" or Barnsley thick coal, under the magnesian formation. The seam, it is expected, will be reached at a depth of from 550 to 600 yards from the surface. At Linby, near to Newstead Abbey, a good start has been made on the estate of Mr. A. Montagu Wilson, of Melton-hall, Yorkshire. The coal-field embraces an area of about 5,000 acres, and the depth of the shaft will be about 500 yards. The Blackwell Company, at Normanton, are going down to the "tophard" seam, and there is some talk of opening out to the dip of the Clifton Colliery, which is situated

close to the town of Nottingham, with a view to decide the question whether the coal measures will be found to proceed in the direction of the vale of Belvoir. At Newstead Abbey the thick coal is being sunk to in a field of 5,000 acres, and the same seam is being opened out at New Watnall. The Mansfield district is also about to be developed, there being a very extensive field of coal lying to the east of the town as well as to the north, proceeding towards Doncaster, near to which an immense virgin field of coal is about to be broken into. The proposed line from Mansfield to Worksop will aid materially in opening out a vast tract of highly mineralized ground, so that collieries will be opened out on a straight course of from 30 to 40 miles. As the production at the many new collieries at Nottinghamshire is estimated at 1,000 tons a day, and as the present output of the 28 collieries in Nottinghamshire is at the rate of 2,500,000 tons a year, no great time will elapse before the quantity is increased to four million tons; while the Doncaster field, with its many thousand acres of fine coal, will also add largely to the production of the country.—*Sheffield Daily Telegraph.*

THE COAL QUESTION.

PROF. WILLIAMSON, in his Lecture to the British Association, sums up as follows:—

"Having now passed in review the principal applications of fuel, with a view chiefly to draw the distinction between our actual consumption and the consumption that would result if our most approved practice was made general; and having, moreover, endeavoured to prove which are the ultimate limits of consumption which are absolutely fixed by theory, but which we shall never be able to realise completely, I will now apply my reasoning to the coal question of the day.

"In looking into the 'Report of the Select Committee appointed to Inquire into the Causes of the present Dearness of Coal,' we find that in 1872 no less than 123,000,000 tons of coal were got up from the mines of England and Wales, notwithstanding famine prices and the colliers' strikes. In 1862 the total getting of coal amounted to only 83,500.000, showing a yearly average increase of consumption of 4.000,000 tons. If this progressive increase continues, our consumption will have reached, thirty years hence, the startling figure of 250,000,000 tons per annum, which would probably result in an increase of price very much in excess of limits yet reached. In estimating last year's increase of price, which has every appearance of being permanent, at 8*s.* per ton all round, and after deducting the 13,000,000 tons which were exported abroad, we find that the British consumer had to pay 44.000,000*l.* more than the market value of former years for his supply of coal—a sufficient sum, one would think, to make him look earnestly into the question of 'waste of fuel,' which, as I shall presently be able to show, is

very great indeed. The Select Committee just quoted sums up its report by the following expression: 'The general conclusion to be drawn from the whole evidence is, that though the production of coal increased in 1872 in a smaller ratio than it had increased in the years immediately preceding, yet if an adequate supply of labour can be obtained, the increase of production will shortly keep pace with that of the last few years.'

"This is surely a very insufficient conclusion to be arrived at by a Select Parliamentary Committee after a long and expensive inquiry; and the worst of it is, that it stands in direct contradiction with the corrected table given in the same report, which shows that the progressive increase of production has been fully maintained during the last two years, having amounted to 5,826,000 for 1871, and 5,717,000 for 1872; whereas the average increase during the last ten years has only been 4,000,000 tons. It is to be hoped that Parliament will not rest satisfied with such a negative result, but will insist to know what can be done to re-establish a proper balance between demand and supply of coal in preventing its conversion into smoke or other equally hurtful or useless forms of energy.

"In taking the 105 million tons of coal consumed in this country last year for our basis, I estimate that, if we could make up our minds to consume our coal in a careful and judicious manner, according to our present lights, we should be able to reduce that consumption by 50 million tons. The realisation of such an economy would certainly evolve very considerable expenditure of capital, and must be a work of time, but what I contend is that our progress in effecting economy ought to be accelerated in order to establish a balance between the present production and the ever-increasing demand for the effects of heat.

"In looking through the statistical returns of the progressive increase of population, of steam power employed, and of production of iron and steel, &c., I find that our necessities increase at a rate of not less than 10 per cent. per annum, whereas our coal consumption increases only at the rate of 4 per cent., showing that the balance of 6 per cent. is met by what may be called our 'intellectual progress.' Now considering the enormous margin for improvement before us, I contend that we should not rest satisfied with this rate of intellectual progress, which involves an annual deficit of 4,000,000 tons to be met by increased coal consumption, but that we should bring our intellectual progress up to the rate of our industrial progress, by which means we should make the coal production nearly a constant quantity for several generations to come; by which time our successors may be expected to have effected another great step in advance towards the theoretical limit of effect, which, as we have seen, lays so far above any actual result which we have as yet attained to, that an annual consumption of 10 million tons would give more than the equivalent of the heat energy which we actually consume.

CORNISH MINING.

PROFESSOR M. MOISSENET, of the School of Mines in Paris, who has already produced several treatises on British Mining, has just published a small volume containing a very complete examination of the phenomena of metalliferous deposits in the mineral lodes of Cornwall.

OUR LEAD AND SILVER.

THE Keeper of Mining Records reports that in the year 1872 83,968 tons of lead ore, of the value of 1,146,165*l.*, were raised and sold in the United Kingdom; and that there was produced from these ores 60,455 tons 15 cwt. of lead, of the value of 1,209,115*l.*, and 628,920 oz. of silver, of the value of 157,230*l.* Therefore, in 100 tons of ore there were 72 tons of lead; in a ton of lead, 10·4 oz. of silver.

A FOSSIL SIRENIAN FROM THE RED CRAG OF SUFFOLK.

AT the opening meeting of the Geological Society, Professor Flower communicated a description of a fine fragment of a skull of an animal of the order *Sirenia*, which is of great interest as affording the first recorded evidence of the former existence of animals of this remarkable group in Britain. The specimen forms part of the very rich collection of Crag fossils formed by the Rev. H. Canham, of Waldringfield, near Woodbridge. It was found in the so-called "coprolite" or bone-bed at the base of the Red Crag, and presents the usual aspect of the mammalian remains from that bed, being heavily mineralised, of a rich dark brown colour, almost black in some parts, with the surface much worn and polished, and marked here and there with the characteristic round or oval shallow pits, the supposed *Pholas* boring.

The fragment consists of the anterior or facial portion of the cranium, which has separated, probably before fossilation, from the posterior part at the fronto-parietal suture, and in a line descending vertically therefrom. This portion has then been subjected to severe attrition, by which the greater part of the pre-maxillary rostrum, the orbital processes of the maxillaries, and other projecting parts, have been removed. In consequence of this, what may be called the external features of the skull, which are especially necessary to determine its closer affinities, are greatly marred, though enough remains of its essential structure to pronounce with confidence as to its general relationship to known forms. Fortunately the whole of the portion of the maxillæ in which the molar series of teeth are implanted is preserved; and though the teeth have fallen from the alveoli in the front part of the series, and in the posterior part are ground down to mere stumps, so that the form of the crowns cannot be ascertained in any, many important dental characters may still

be deduced from the number, form, size and position of the sockets and roots that remain.

As the intensely hard, ivory-like rostra of the ziphioid Cetaceans, the tympanic bones of the Balænidæ, and the teeth of terrestrial mammals, almost alone remain in these deposits to attest the former existence of their owners; it is, doubtless, to the extreme massiveness and density of the cranial bones, as characteristic of the order Sirenia, that we owe the preservation of so large a portion of the skull under the very unfavourable conditions to which it, in common with the other fossils of the formation, must have been exposed.

After a comparison of the characters of the cranium with those of the several existing and extinct members of the order, Professor Flower referred it to the genus *Halitherium*, and showed its relationship to *H. Schinzi* of Kaup from the miocene of the Rhine basin—a formation, it will be remembered, in which several animals of the Red Crag bone-bed occur. It is, however, of larger size than that species; the teeth are larger, both absolutely and relatively to the cranium, and certain other differences occur, though the imperfect nature of the materials makes exact comparison of fossils only known from fragments not altogether easy or satisfactory. Believing, however, that it does not belong to either of the above-mentioned, or any other of the hitherto described species of *Halitherium*, the specific name of *H. canhami* was proposed. It should be mentioned that there are six teeth in the maxillary or molar series on each side, all present at the same time, the first two with single roots, the third with two roots, and the last three with three roots, precisely resembling in form those of the molar teeth of the existing Manati.—*Nature.*

NEW FOSSILS.

Some of the most interesting discoveries made last summer by Dr. Hayden's exploring party are due to the labours of Professor Cope in palæontological researches among the Bad Lands of Colorado. The remains are even more interesting than in the similar regions of Wyoming. They have been found to be a vast graveyard of animals belonging to a long past period of the earth's existence. Up to the present time, Professor Cope has proved the existence of more than 100 species, represented by thousands of individuals. Of these at least 10 are new to science. They range from the size of the mole to nearly that of the elephant. Sixteen species are reptiles. Many forms of insectiverous animals, related to the mole and of very small size, have been procured. The delicacy and minuteness of these fossils is surprising. Gnawing animals, or rodentes, left numerous remains of 18 species, some no larger than the domestic mouse. Some were the predecessors of the rabbits, some of the squirrels, and some of the mice. Of cloven-hoofed quadrupeds

a great many have been found. Some were nearly intermediate in structure between the deer and the hog. Like the latter, they had no horns. They were about as large as sheep. Others were about the size of gray squirrels, being the smallest of this class of animals ever discovered. Several species of horses were living during the same period, as is proved by the bones and teeth which have been obtained. Their relatives the rhinoceros abounded in Colorado in former days, no less than seven species having been procured by Professor Cope. One of the specimens is a perfect skull, with teeth complete, and covered with the crystallisation seen in the moss-agate.

But the most remarkable monsters of the past whose existence has been disclosed by this summer's survey are a series of horned species related to the rhinoceros, but possessing some features in which, according to Professor Cope, they resembled the elephant. They stood high on the legs and had short feet, but possessed osseous horns in pairs on different parts of the head. One of the largest species had a large horn over each eye, while one had another on each side of the nose more than a foot in length. A third one, of a larger size than the last, had rudimental horns on the nose. Still another was as large as the elephant. Its cheek-bones were enormously expanded, and its horns were flat. A fifth species had triangular horns turned outwards. Their structure is regarded as disposing of the statement of a recent writer that the presence of horns in pairs is an indication of relationship to the ruminating animals, for these beasts are near the rhinoceros. Carnivorous species were not rare in this ancient family, and served, as now, to check the too rapid increase. Of the 14 species known there were tiger-cats, dogs, hyænodons, and the tomarctos, a new genus found by Professor Cope. It resembled the dog, and was as large as the black bear, but it was not much more carnivorous in its propensities. The reptiles embrace turtles, lizards, and snakes. The last two orders were discovered for the first time in this formation in America. In the last few years Professor Cope has obtained from the ancient sea and lake deposits of Kansas, Colorado, Wyoming, Idaho, &c., about 300 species of vertebrated animals, of which he has made known to science for the first time more than 200. The history of the succession of life on this continent will be greatly elucidated by proper investigations of the specimens preserved by the survey.—*Times*.

SILICA.

A PAPER has been read before the Geologists' Association, by Mr. Hawkins Johnson, F.G.S., on "The Nature and Formation of Flints and allied Bodies." The object of the paper is to show the nature of several members of a large group of bodies occurring in sedimentary deposits of different ages, and which are

generally known as nodules, and described as concretionary. Those specially alluded to are the Septaria from the London and Kimmeridge clays, the flints from the chalk, the iron pyrites from the chalk, the phosphatic nodules of the Gault, the clay ironstone nodules of the carboniferous series, and the ironstone from the Woolwich beds. By the gentle action of solvents the structure of these bodies is revealed, so as to be easily examined by the microscope. They are then found all to agree in possessing a silicified organic structure, which may be described as a network of fibres, or a mass permeated in every direction by anastomosing canals. This structure was subsequently filled in with other material, such as carbonate of lime, silica, bisulphide of iron, phosphate of lime, carbonate of iron, &c.; the particular substance thus filled in depending upon the relative abundance of the substances dissolved in the interstitial water of the surrounding matrix. The singular groups of concentric, silicious, circular bands seen upon many fossils, and known as Orbicular Silica, or Beekite markings, are also explained. The fossils on which they occur were imbedded in a matrix more porous than themselves, and of irregular constitution, so that the evaporation, to which the consolidation of the dissolved silica in their pores was mainly due, occurred at a number of points on the surface of the fossils, at which points a deposits of silica took place, forming the central tubercles. The cessation of evaporation was followed by a fresh saturation with the solution, to be again evaporated as before. But, as the evaporating points were now plugged up by the previous deposits, the silica last consolidated was deposited around their margins, and upon them internally, appearing outwardly as a ring round the tubercle.—*Builder*.

VOLCANIC ERUPTION IN HAWAII.

THE phenomenon of a pillar of fire rising from a crater, on the summit of a mountain nearly as high as Mont Blanc, is reported in Hawaii. At the end of last August an old missionary of Hawaii, the excellent Titus Coan, wrote to Mr. Dana, the American geologist, that another eruption of Mauna Loa had taken place. A vast cloud of fiery vapour rose above the lofty volcano; at times it formed a magnificent column at least 2,000 ft. in height. Though seen at the distance of many miles, the changes of this illuminated pile were distinctly apparent. It was, indeed, a glorious sight when the head expanded and spread out a palm-tree of fire.

Mauna Loa, almost 14,000 ft. above the level of the sea, is one of the many volcanic peaks of that Iceland of the North Pacific, Hawaii; but this, the largest of the Hawaiian or Sandwich group of islands, instead of being like its fiery rival near the frozen zone, is fanned by the voluptuous airs of the tropics. It is but one-eighth the area of Ireland, though a very Switzerland of mountains and valleys. The well-known port of Hono-

lulu, half way between China and California, is in the neighbouring smaller volcanic island of Oahu.

Among the many hundred peaks from which the fiery current has flowed none has been so celebrated in modern times as that of Mauna Loa. The highest point is 13,950 ft. above the sea. It is however, a double mountain, the loftier peak being Mauna Kea. This has nine cones about its top, while Loa is but a single dome. Upon the side, though 10,000 ft. below, spreads out the largest burning crater in the world—Kilanea. In that crater 3,000,000 square yards are sunk nearly 1,000 ft. below the rim of the crater. A number of boiling cauldrons are perpetually hissing there with their bubbling lava, which has repeatedly overflowed, to the devastation of whole provinces around.

Above this terrific scene of volcanic violence rises the snow-crest of Mauna Loa. Eruptions are less frequent from the summit than from the crater at its side. But in 1843 a current of lava poured forth from it. This was repeated in 1852, though the point of issue was 4,000 ft. below the top. In 1859 a stream ran fifty miles before it leaped over a mighty cliff into the ocean. When first it burst from the womb of the mountain it formed a mighty arch of fire 250 ft. in height, and then rolled down in a succession of wonderful cascades from crag to crag. In 1868 a dreadful eruption took place. Earthquakes of frightful energy shook the whole island. In ten seconds every building in a whole district was overthrown. A smiling valley, in which a flourishing village was nestled and large flocks and herds were depastured, suddenly threw forth a vast volume of boiling hot mud, and soon after that a flood of cold water. Along the coast the sea rose and fell, to the desolation of several villages.

In August and September of last year a still more wonderful eruption took place on Mauna Loa. On the huge platform, four times the height of Vesuvius, are two large craters, and two much smaller ones. The two former are Mokuaweoweo and Pohakuohamalei. The first is that which was convulsed last year. One who visited it in quieter times described the crater walls as being 470 ft. deep on one side and 784 ft. on the other. As many as seventy distinct layers of basalt were counted in one part. Dr. Judd descended the nearly perpendicular wall to the bottom. There he had to walk over ridges of clinker and basalt, running from 10 ft. to 50 ft. high, which took him two hours to cross. Here and there he noticed stupendous caverns, lined with the delicate fibres of volcanic matter, called Pélé's-hair. This hung about like cobwebs. Yet the crater was so still and peaceful that he ventured to plant some orange seeds in the moist and rich soil, in the hope that future visitors might gather the luscious fruit there.

The last visitor to Mokuaweoweo has another tale to tell. He could trace the oval crater three miles round. He could see the floor on which Dr. Judd had trod in safety. But a portion

of this had given way, perhaps 100 ft. below. In one part of this depressed basin was a pool of fire. It was from that he saw this singular column rise. He calls it a "magnificent fountain of liquid lava, about 75 ft. in diameter, that sent its volume of brilliant, sparkling, molten matter to a height estimated at 500 ft. in a compact and powerful jet."

As he looked downwards and across, at a distance of three quarters of a mile, he saw that the fountain formed an arch. The fiery current rose in a slightly slanted direction, so that the mass fell perpendicularly in the descent. The roar of the flames was as the sound of a heavy surf upon the shore. But the fountain carried up with it enormous masses of white-hot rock. "These," he says, "as they fell and struck upon the black surface of the cooling lava, burst like meteors in a summer sky." He compares the report of these explosions to the heavy rush of ponderous waves against the rock-girt shore.

At night the sight was glorious indeed. The column still rose from the burning lake. Fiery falls were seen along the course of the flaming river below, while the fiery foam swirled round the waves of this terrific cauldron. An engraving of this terrific phenomenon has appeared in the *Illustrated London News*.

GAS FROM VESUVIUS.

M. Diego Franco, who is attached to the Observatory on Mount Vesuvius, has long occupied himself with the study of the gaseous emanations from that volcano. He has just published a paper, entitled "L'Acide Carbonique du Vésuve," in which he records a large number of observations on the carbonic acid gas evolved under different conditions from this source.

EARTHQUAKES AND VOLCANIC PHENOMENA.

In the *Repertorium für Experimental Physik* M. Carl has recently produced some new views on earthquake and volcanic phenomena. He supposes that at a considerable depth beneath the surface the heat may be sufficient to cause water to assume the spheroidal state of Boutigney, developing slowly vapour of great tension, which under a slight change of circumstances might become the source of enormous explosive forces.

THE NEW AFRICAN GOLD DISCOVERIES.

A Correspondent of *The Times* writes:—"By the last mail we have important news from Natal. Some years ago the people and journals of that colony, led away by Herr Mauch's vivid descriptions, announced to all parts of the world that gold had been discovered in immense fields. The result was that many came from all parts of the world, and were disappointed.

"Gold there was, no doubt, but it was not to be found in quantities which would pay the diggers. Since then there has

been continual talk of finding the precious metal in different localities; but the papers, warned by the odium they incurred on that occasion, have been very careful as to publishing the various reports.

"This time I have no hesitation in believing what is told us. In 1871, when I was in the neighbourhood of the district in which auriferous deposits have been discovered, I heard many stories from the natives of gold being there. There were white men also at work, but they said very little as to their progress—a very good sign of success; and now, instead of being suddenly blazoned forth, the stories have gradually increased in volume, until the announcement has been, in a manner, forced from the Natal papers. Within a year or two I fully believe that we shall see a large mining population at work, and the exports of gold beginning to rival those from Australia, the gold-bearing districts of which are in much the same parallels of latitude.

"The present gold fields are situated in a country which is claimed by the Transvaal Republic, another petty Dutch Boer State which Britain has allowed to establish itself on the North East of Natal, but which is in reality native territory. The Boers have many curious modes of annexing native lands. I will give you one out of my experience.

"A certain district was required so as to give a right of way to the coast from New Scotland (a settlement in the eastern part of the Transvaal). The operating agent, who was in this case an Englishman, approached the chief with a request to be allowed to cut a few trees in the forest, for which he paid him about 15*l*. or 20*l*. worth of blankets. Of course, the request was granted, and some timber was felled. It so happened that this forest swarmed with monkeys, the skins of which were valuable for purposes of trade, among the neighbouring and powerful nation of the Zulus. I wished to place some native hunters there for the purpose of shooting those monkeys, and applied to the chief for the purpose of doing so, offering him a couple of blankets in return, which usually would have been ample remuneration. 'No, no,' said the chief. 'The white man has given me all these goods for mere permission to cut trees. You, who wish to deprive us of our very means of existence, since it is only by possessing these skins that we are enabled to pay tribute to the Lulus, only offer me two blankets. No, no.'

"I met the Englishman afterwards, and he acknowledged that it had been done with a view to asserting that the land had been bought.

"Wars have been prevented by the interposition of the English Government of Natal, and the sparseness of the white population has so far prevented the natives from feeling any pressure; but when we remember the results of this class of bargains between whites and Maories in New Zealand, we may well anticipate trouble and adopt measures to avoid it.

"Again, on the coast at Delagoa Bay—the nearest seaport by far to the gold fields—we have the Portuguese, shut up in their factory of Lorenço Marques, and holding their ground only by keeping up wars and anarchy among the natives.

"In 1823 Captain Owen, in Her Majesty's ship *Leven*, visited the bay, and entered into a treaty with the chiefs south of English River (on the north bank of which Lorenço Marques is situated), by which they ceded their territory to Great Britain fully and freely. If Britain does not retain a footing in Delagoa Bay she cannot control these diggers, unless she first annexes the Transvaal, and then only through 500 miles of weary, rugged road from Natal, the nearest seaport. If she retains her undoubted right to the south bank of English River, she is within 150 miles of the fields, with a country between which is remarkably fertile, level, and easily travelled."

As the verification of the reports as to the discovery of Gold in South Africa is a matter of public importance, we beg to state that a nugget from the Leydenberg diggings, weighing 18oz., has arrived per steamship *European*, and can be seen here by any one interested.—*Mercer and Co.*, 11 *Leadenhall Street, London.*

GOLD IN FINLAND.

In the Russian province of Finland there were during last summer seventeen companies occupied in washing gold, and they employed about 500 men. The gold is found at Tvalo in a diluvial deposit, which has proved to be rather rich. The total yield of last summer's campaign is estimated at from 50,000 to 60,000 grammes, or from 500 to 560 ounces, worth about 60,000 roubles. The Helsingfors Company has gained over 11,000 grammes, and paid a dividend of 60 to 70 per cent., or rather less than the year before. The gold is principally found on the beach, and in the tributaries of the Palsyoja river, the largest nugget found last summer weighing 40 grammes.

AUSTRALASIAN GOLD.

The imports of Australasian gold into the United Kingdom in 1873 exhibited a large increase as compared with 1872, having amounted to 9,471,601*l*. as compared with 6,014,621*l*. in 1872, and 6,919,480*l*. in 1871. The increase in the imports was still continuing at the close of last year, the receipts of December having been 1,341,672*l*. as compared with 618,996*l*. in 1872, and 433,647*l*. in 1871. The Star of Peace Company, Hawkin's-hill, New South Wales, has cut a rich vein of stone in its new shaft, and specimens which have reached Sydney were considered highly satisfactory. The quartz is thickly sprinkled with gold, which is seen on both sides. The yield of gold from quartz from the hill still continues generally encouraging.

A discovery of gold, which promises to be of some importance, has been made near Reedy Creek, in New south Wales. Assays of gold-bearing stone from the Northern Territory of South Australia have yielded from 20 oz. to 50 oz. to the ton. Gold has been found in Kangaroo Island, South Australia. Some attention is being devoted to gold working in Tasmania; at the City of Hobart claim the crushing of 204 tons of quartz yielded 250 oz. of gold.

FOSSIL BIRDS AND REPTILES.

There have been read to the Geological Society "New Facts bearing on the Inquiry concerning Forms intermediate between Birds and Reptiles," by Henry Woodward, F.R.S. The author, after giving a brief sketch of the Sauropsida, and referring especially to those points in which the Pterosaurians approach and differ from birds, spoke of the fossil birds and land reptiles which he considered to link together more closely the Sauropsida as a class. The most remarkable recent discoveries of fossil birds are:—(I.) *Archæopteryx macrura* (Owen). (II.) *Ichthyornis dispar* (Marsh), (III.) *Odontopteryx toliapica* (Owen). The author then referred to the Dinosauria, some of which he considered to present points of structure tending towards the so-called wingless birds. (I.) *Compsognathus longipes* (A. Wagner), from the Oolite of Solenhofen. (II.) The huge carnivorous *Megalosaurus*, ranging from the Lias to the Wealden. The author next drew attention to the Frilled Lizard of Australia, *Chlamydosaurus Kingii* (Gray), which has its fore limbs very much smaller than the hind limbs, and has been observed not only to sit up occasionally, but to run habitually upon the ground on its hind legs, its fore paws not touching the earth, which upright carriage necessitates special modifications of the sacrum and pelvis bones. The Solenhofen Limestone, in which Pterosauria are frequent, and which has yielded the remains of *Archæopteryx* and of *Compsognathus*, has also furnished a slab bearing a bipedal track, resembling what might be produced by *Chlamydosaurus* or *Compsognathus*. It shows a median track formed by the tail in being drawn along the ground; on each side of this the hind feet with outspread toes leave their mark, while the fore feet just touch the ground, leaving dot-like impressions nearer the median line.—*Nature.*

REPORT OF THE COMMITTEE FOR EXPLORING THE SETTLE CAVE.

This cave is of great interest, and is being explored by a local committee, aided by a grant from the British Association. In the newest layers there is evidence of human occupation during the historic period; but in the older cave earth, which contains the remains of extinct mammalia, no trace of man has yet been discovered. The exact age of the cave earth is a matter of dispute. Mr. Tiddeman, from the physical evidence alone,

regards it as pre-glacial, or rather as older than the great ice-sheet of that district. Mr. W. Boyd Dawkins, F.R.S., whilst doubting the physical evidence afforded by the cave alone, is inclined to regard the fauna as pre-glacial, and he remarks:—"It is obvious that the hyænas, bears, mammoths, and other creatures found in the pleistocene stratum, could not have occupied the district when it was covered by ice; and had they lived soon after the retreat of the ice-sheet, their remains would occur in the river-gravels, from which they are absent throughout a large area to the north of a line drawn between Chester and York, whilst they occur abundantly in the first glacial river deposits south of that line. On the other hand, they belong to a fauna that overran Europe, and must have occupied this very region, before the glacial period. It may, therefore, reasonably be concluded that they occupied the cave in pre-glacial times, and that the stratum in which their remains lie buried was protected from the grinding of the ice-sheet, which destroyed nearly all the surface accumulations in the river-valleys, by the walls and roof of rock, which has since, to a great extent, weathered away."—*Nature.*

Mr. Dawkins describes the work done during the past year in exploring the Victoria Cave at Settle, and many members of the British Association Section visited the cave, and examined the magnificent collections of bones now deposited in the Museum of the Grammar School at Giggleswick. In the Settle Cave no traces of man have yet been discovered in the cave earth, wherein are imbedded the bones and teeth of the ordinary extinct cave mammalia; but in the higher layers there is abundant evidence of human habitation during the time of the Roman occupation.

LAKE DWELLINGS.

According to Dr. Fritsch, the discovery has lately been made of lacustrine dwellings in the vicinity of Leipsic, as the result of certain engineering operations undertaken to regulate the course of the River Elster. After passing through a series of layers at a certain depth, the workmen found a series of oak piles pointed below and decomposed above, and supporting a certain number of oak trunks placed horizontally; and on the same level with these were found certain lower jaws and teeth of oxen, fragments of antlers, broken bones of various mammifers, shells of an Anodon, fragments of pottery, two polished stone hatchets, &c.

SUB-WEALDEN EXPLORATION.

Mr. S. H. Beckles, writing from London, on Oct. 27th, says:—"The occurrence of Kimmeridge clay immediately below

the Wealden is to me at once deeply interesting and not surprising. It may be remembered that when, a few years ago, an Artesian boring going on at Hastings was supposed to have reached the Purbeck beds, I intimated that these strata would not be met with at all. And subsequently I stated that I was unable to detect the Purbeck strata where Sir Henry de la Bêche supposed them to outcrop. Fortunately, at the commencement of the boring now in progress, I expressed a belief to a scientific friend that the Kimmeridge clays would be the first Sub-Wealden strata we should encounter."

The fifth quarterly Report on the Sub-Wealden Exploration has been issued by Mr. H. Willett, of Brighton. The present depth from the surface is 313 feet; some important geological facts have been decided, and valuable beds of gypsum discovered. The more interesting facts are that the Kimmeridge clay is identical in deposit with that in the Boulonnais district of France, and that the Wealden estuary did formerly extend across the Channel in an unbroken continuity. The probability that coal may be found is therefore greatly increased by the discovery of strata in Sussex identical with those in the Boulonnais district. This investigation was to be continued until the depth of 1,000 feet had been reached.

REPORT ON EARTHQUAKES IN SCOTLAND.

In 1872 a Report by Dr. J. Bryce, F.G.S., on this subject was read at Brighton in 1872, stating that there had been but little to record during the year then reported on; but whilst the British Association was sitting a shock occurred in the Comrie district, an account of which is given in the report now presented. The earthquake occurred on August 8, 1872, at from 8m. to 10m. past four o'clock in the afternoon. The successive phases, according to almost all the observers, were a noise or sound, loud, heavy and rumbling; a shock with a shaking and rattling of objects; and a wave-like motion of the ground. The undulations appear to have come from the W. or N.W.; according to some observers, from the opposite direction; but these probably did not distinguish between the first impulse and the recoil.

The extent of country through which the shock was felt is greater than that of any which has occurred since this inquiry was undertaken. The limits are marked by Stirling and Blair Logie on the S.E., and by St. Filians on Loch Earn and Glen Lednock on the N.W. The shock was feebler at their limits than in the country between, as about the Bridge of Allan, Dunblane, &c. The breadth of the disturbed area does not appear to have extended more than two or three miles from the Allan Water; the shock seems to have emanated near Comrie. The geological formation of the district are very various in character, and it does not appear that any connection can be

traced between the nature of the rock forming the surface and the severity of the shock.

Another shock, which occurred at 9.55 P.M. on April 16, 1873, is briefly described. This was in the south of Scotland, in the parishes of Tyrone, Glencairn, and others adjacent. According to one observer, there was another shock in this district at 2.46 A.M. on the following morning.

EARTHQUAKE IN TURKEY.

On September 1 an earthquake took place at 4.10 P.M., with slight shocks, at Drama, in European Turkey. There was an earthquake at about 9 P.M. on September 6, in Armenia, at Erzeroum, and elsewhere. Several shocks of earthquake were felt on August 21, in the city of Guatemala; but very few houses were damaged.

THE OPAL AND THE DIAMOND.

Some observations on the spectrum of the precious opal have been recently published by Dr. Behrens, of Kiel. The light reflected from the surface of this gem gives a spectrum consisting of one or two bright lines; the purity of the colours of the opal may be referred to the homogeneity of this reflected light. Behrens's researches are described and illustrated in the last number of Leonhard and Geinitz's *Neues Jahrbuch*.

A somewhat novel idea is started by M. Desdemaines Hugon, in a paper "On the Diamond Diggings of South Africa," which is printed in the *Revue Scientifique de la France et de l'Étranger*. He states that the air is always highly electric where diamonds abound, and he intimates his opinion that this may throw some light on the formation of that gem.—*Athenæum*.

Signor D. Mariano Barcema, Secretary of the Sociedad Mexicana de Historia Naturel, has published in *La Naturaleza* an account of opals from a new locality. Specimens have been sent to this country, and they are of great beauty. They are found in the state of Queretaro, ten leagues north-west of San Juan del Rio, in the Hacienda of Esperanza. These opals are of the first quality, and of all varieties—the milk opals, the fire opals, girasols or "harlequins," with various kinds of richest precious or Hungarian opals.

TRUE JADE OR NEPHRITE.

An admirable paper, "On the Jade of the Kuenlun Mountains," has been communicated to the Academy of Sciences of Munich by Hermann von Schlagintweit, and published in the *Sitzungsberichte* of the Academy. The author visited the quarries on the Kara-kash river, which formerly supplied the Chinese with much of their jade. It may be remembered that these quarries were popularly described some time ago by Dr.

Cayley. Although the title of Schlagintweit's paper refers only to the jade of Khotan, yet the author gives much information respecting the mineral from other localities, and discusses the source of the trade, which is found in the pile-dwellings of the Swiss lakes. He also clearly points out the means of distinguishing true jade, or nephrite, from the closely-allied minerals known as jadeite and saussurite.

PRECIOUS STONES ARTIFICIALLY PRODUCED.

M. VIOLETTE, of Lille, has succeeded in melting platinum in a Hessian crucible in a common furnace. It is expected that various kinds of precious stones may be artifically produced by melting aluminium with borax, the opal, sapphire, ruby, emerald, and others being only coloured alumina.

PERUVIAN GUANO.

MR. C. S. READ, M.P. for South Norfolk, observes in a letter to Earl Granville:—"I would respectfully impress upon your lordship the necessity of an English survey being speedily made of the various deposits of guano in the Pacific. This is the more needful as the estimates of the Peruvian Government have proved to be unfortunately fallacious. In 1853 the Peruvian Government made an estimate of the guano in the Chinchas at 26,000,000 tons. Admiral Moresby was ordered by Lord Palmerston to give a report, and he made it 8,600,000 tons. The whole quantity which has been shipped from 1853 to 1871, when the islands were cleared, was only about 7,250,000 tons, proving the comparative accuracy of the English Admiral's survey. The British Consul's return to the Foreign Office in 1873 estimates the entire quantity of Peruvian Guano in the Guanape and Macobei Islands and in Lobos at 3,000,000 tons, while the Lima press reports the ascertained value of existing Peruvian deposits to be 70,000,000*l.* sterling."

COLORADO TERRITORY.

ONE of the special results of the United States Geological and Geographical Survey of the Territories, in charge of Professor F. V. Hayden, during the past summer, has been the discovery that Colorado Territory is the centre of the greatest elevation of the Rocky Mountain chain. In Central Colorado the chain proper is about 120 miles broad, made up of three lofty parallel ranges, running nearly north-north-west, and flanked from the west by great plateaus and groups of peaks. Between the ranges lie the great elevated basins known as "parks." The front range, which rises abruptly from the plains, is seen from Denver in a grand panorama 120 miles long.

THE ANDES ON A DECLINE.

A RECENT number of the *Ausland* tells a sad story of diminished altitudes. Quito was found by La Condamine, in 1745, to be 9,596ft. above the sea; Humboldt, in 1803, could only make 9,570ft. of it; Boussingault, in 1831, was startled to find it was only 9,567ft.; Orton, in 1867, found it reduced to 9,520ft.; and Reiss and Stubel found, in 1870, that it had shrunk to only 9,356ft. above the level of the sea. Quito, it seems, has sunk 246ft. in 125 years, and Pichincha 218ft. in the same period. Its crater has sunk 425ft. during the last 26 years, and Antisana 165ft. in 64 years.

BIRMINGHAM NATURAL HISTORY AND MICROSCOPICAL SOCIETY.

A PARTY from the Society proceeded to Teignmouth, early in September, on a marine excursion, in the yacht *Ruby*. Dredging operations commenced on Monday, September 1, and were continued daily throughout the week, in depths varying from $5\frac{1}{2}$ to 20 fathoms. The atmospheric, surface, and bottom temperatures were taken at each sounding, the maximum and minimum results being as follows:—

Atmospheric temperature,	Maximum	66°	Minimum 64°
Surface ,, ,,	,,	61°	,, $58\frac{1}{2}$°
Bottom ,, ,,	,,	$60\frac{1}{2}$°	,, 58°

The averages were: atmospheric, $65\frac{1}{4}$°, surface, $59\frac{1}{2}$°, bottom, $58\frac{3}{4}$°. A Miller-Casellar thermometer was used. On the whole the results of the dredging were very satisfactory. About thirty hauls of the dredge were made, and specimens of many of the marine invertebrate animals in the neighbourhood secured. The tangles attached to the bag of the dredge sometimes came up literally swarming with echinoderms. By far the most noteworthy capture was *Comatula rosacea*, the feather-star, two individuals of which were taken in the larval pedunculate condition attached near the base of a frond of *Laminaria*, which was torn off by the dredge. The specimens measured about one-third of an inch in length. Five young Comatulæ in a free condition, the largest about an inch across, were also taken. The members of the Society had the unusually rare opportunity of seeing under the microscope the young feather-stars in the living state. They were but little thicker than sewing-silk, of graceful, erect, lily-like form, and very lively, bending and waving on the peduncle; the arms vigorously contracting in an inward direction. The members had the opportunity of examining under the microscope the pedicellariæ of the star-fishes and sea-urchins, and the whip and bird's-head processes of certain of the polyzoa; also the structure of Botryllus and other tunicates, the larval forms of crustacea, &c. In the course of the week very enjoyable excursions were made by some of the members down the River Dart to Berry-Pomeroy Castle, Lustleigh, Becky Falls, Moreton

Hampstead, Chagford, Exeter, Torquay, &c. The members of the Society who remained in Devonshire after the marine excursion were escorted through the famous cavern by W. Pengelly, F.R.S., who courteously explained to them the mode of conducting the explorations, the contents of the flora, and their relation to geological time. Mr. Pengelly also showed them at his own house the collection of bones, teeth, &c., of man, and the extinct bear, hyæna, dog, and other animals, and the flint implements of earlier and later manufacture found therewith in the cavern.—Abridged from *Nature.*

THE FLORA OF SPITZBERGEN.

OF the *Diana*, screw steamer, in which Mr. B. L. Smith left Dundee in May last on a voyage of discovery to the Polar Seas, by the Spitzbergen route, the *Daily News* sums up the result:—"A succession of gales was experienced—the weather on almost all occasions when the ship was in the open sea being such that, although she was provided with complete apparatus for sounding, deep-sea temperatures, &c., not nearly what was intended has been accomplished. Owing to the unfavourable nature of the ice, little in the way of exploration has been possible. The time had, however, been very fully occupied in dredging, trawling, photographing, surveying, and making as complete and perfect collections as circumstances permitted of the Flora of Spitzbergen. Specimens of rare birds have been secured, and collections made, probably the first of any value. The collections of marine plants and animals are likely to prove especially interesting; and it has been discovered, among other things, that some parts of those seas hitherto reported as almost destitute of fish abound in cod of excellent quality. In the way of geology everything possible was done in the parts unexplored by the Swedes, and numerous specimens of fossils have been brought back from the hitherto unvisited parts of the coast of the north-east land. From the appearance of open water seen in this expedition beyond Cape Platen, and also reported by the Swedes as existing—ascertained during their sleigh journey—it seems to be by no means certain that the route farther northwards which the *Diana* on leaving England hoped to reach does not exist, and the question still remains open, were it possible to reach this early in the season, whether a means of reaching a higher latitude to the north-east of Spitzbergen is not available. Mr. Smith has ascertained that the North Cape is situated on an island separated by a sound from the main land, and to this extent a knotty point has been determined. The expedition never got beyond 81°, while Mr. Smith in his expedition of 1871 got to 81·24°. He states that the *Diana* behaved admirably, but he did not realise his anticipations which would be achieved by the substitution of steam for sailing power."

CAVE-HUNTING.

Mr. Boyd Dawkins' new work on Cave-hunting has added much to our knowledge of ancient man. It will comprise the physical history of caves and their relation to the general physical geography of the district, as well as the history of their contents; and will treat of the men who have inhabited the caves of France, Spain, and Britain, during the historic, prehistoric, and pleistocene ages.

THE NEW PACTOLUS.

Messrs. Edwin Fox and Bousfield have sold in four lots one quarter of a King's Share in the New River Company for the sum of 12,240*l*., the income for the last year having been on this quarter share 448*l*. The rise in value in this property has been very marked. In 1858 a share sold in the open market at the rate of 19,000*l*. Twelve years after the auctioneers above-named sold a share in lots at 38,000*l*., and the result of this last sale shows the price of a share to be now nearly 40,000*l*.—*Pall Mall Gazette.*

A NEW MAP OF THE UNITED STATES.

By direction of Commissioner Drummond, acting under a law passed last session, a New Map of the United States and Territories has been prepared in the General Land Office, showing the extent of public survey, Indian and military reservations, railroads and canals, all land grants, important features of topography, and many other details compiled, from official surveys and other authentic sources, up to August 15 of the current year. This map corrects the numerous errors of all previous maps, and embodies a large number of results of the latest scientific research and exploration. Owing to the smallness of the appropriation available for its preparation, only a few copies of the map can now be printed, but it is expected that Congress will provide means for its wide distribution.

VOLCANOES IN ICELAND.

The past winter was very mild in the southern portion of Iceland, but quite severe in the northern. In the middle of January an eruption of the Volcanoes in the great Yokul Mountains, in the south-east corner of the island, took place, which continued with unusual violence for about a week, and then suddenly ceased. Since then no fire has been noticed. Large quantities of ashes have fallen on different localities, but it is believed that the deep bed of snow protected the pasture lands from destruction. Volcanic eruptions took place at the same time in Chili.—*Nature.*

COMPRESSED PEAT.

Hitherto all attempts to produce peat fuel fit for general use, on a commercially remunerative scale, have failed, one great obstacle having been the water which the native peat contains, and to get rid of which has, in some instances, required an expenditure of fuel which neutralized any advantage that might otherwise have been obtained. But although the various attempts to utilize peat have been attended with failure, they have at least demonstrated progress, and have been sufficiently successful to encourage some to take up the question at the point where others have broken down. Among those who have devoted some years of time and much attention to the practical solution of the problem is the firm of Clayton, Sons, and Howlett, of the Atlas Works, Harrow-road, who have seemingly perfected the mechanical means of producing condensed peat fuel on a commercial scale, and at a *minimum* and remunerative cost. The apparatus for this purpose is fitted up at Messrs. Clayton's works, and has been visited by the Duke of Sutherland and a select party of gentlemen interested in the conversion of waste peat bogs into profitable fuel. The first part of the process consists in expressing as much of the free water as possible from the peat, and this is effected by means of squeezing trucks, which are run on a tramway from the bog to the machinery. The peat is filled into the truck, which is an iron cylinder having doors at the top and a piston within, actuated by a screw worked from a handle at the side. The truck having been filled with raw peat, fastened down and started, an attendant turns the handle on the way to the machine shed, and thus expels the free water, which issues from apertures in the cylinder. The process of manufacture is conducted in a machine which consists of a vertical cylinder about 2ft. in diameter, in which works a central shaft, armed with cutters, and in which the fibrous peat is first broken up. Arrived at the bottom of this cylinder, the peat is conducted by an elbow into a horizontal cylinder of the same diameter as the first, and in which revolves a shaft fitted with a set of blades or cutters, arranged round the shaft in the form of a screw, and working in between a series of steel knives fixed along the bottom of the cylinder. By these means, the peat is reduced to a state of fine pulp, and is finally compressed by the aid of a screw, and delivered through the discharging end of the machine, whence it issues in three streams, each 3½ inches wide by 2½ inches deep. As the streams issue from the apparatus they are delivered on to trays in lengths of about 3ft., the stream being cut off by a wire cutter when a sufficient length has been received. Another tray is ready to receive the issuing peat, and the process is thus maintained continuously. The trays of peat are run forward to a wire cutting-frame, which is brought down upon the peat, and divides each of the three lengths into six pieces, each 5 inches

long by 3½ inches wide and 2¼ inches deep. The trays of briquettes thus formed are then removed to the drying sheds, where they are placed in racks and air-dried, this final process occupying about eighteen days, at the end of which time the peat is ready for the market. The briquettes when dry measure 3 inches by 2 inches by 1 inch, a considerable shrinkage being caused by the drying. The peat used in the above trials was brought from Huddersfield, and was chiefly top peat of a very fibrous nature. The resulting yield, however, was perfectly homogeneous, and very satisfactory as regards quality. As the quantity of peat fed to the machine was not weighed, and as time could not be taken properly—the working being purposely intermittent for the benefit of those present—no data were then arrived at as to the capacity of the apparatus. From previous trials, however, which were carefully conducted in the presence of scientific gentlemen, it appears that the apparatus will turn out 75 tons of moulded peat in 10 hours. These 75 tons, it has been proved, will yield about 15 tons of dried peat, of an average density of 1·25; these figures, however, are variable, and are dependent mainly upon the condition of the bog and the depth from which the peat has been taken. As regards cost of production, that is placed by Messrs. Clayton at 5s. per ton, inclusive of an eight-horse power engine to drive the machine and all manual labour. The result of the manufacture, then, is a fuel of about the same density and specific gravity as coal, and which, as far as it has yet been proved, answers equally well as a fuel either for domestic purposes or for generating steam.—Abridged from the *Times*.

Astronomy and Meteorology.

HONOURS TO ASTRONOMY.

THE French Academy have elected Mr. Huggins, F.R.S., and Professor Simon Newcomb, of America, correspondents in the Section of Astronomy. Professor Newcomb has been awarded this year's Gold Medal of the Royal Astronomical Society for his tables of Neptune; and Mr. Huggins, who is well-known for his discoveries as to the physical constitution of the stars and nebulæ, has also recently been appointed by the Emperor of Brazil a Commander of the Order of the Rose.

THE SHAPE OF THE SUN.

IN 1809 Lindenau found, in reducing certain observations of the sun, that there were differences in the observed diameters, which he thought could not be explained by errors of observation, as they seemed to be of a periodic nature; and he suggested the hypothesis that the sun was not quite spherical in shape, but spheroidal, and rotating about its major axis. Recently Father Secchi, of Rome, unaware of Lindenau's investigation, conjectured that the effect of the active forces in the sun may produce changes of volume in the masses of luminous gas that surround it, which would be, perhaps, perceptible in accurate observations of the sun's diameter. He accordingly had regular observations made from June 1871, at the Observatory of the Collegio Romano, and, at his instance, similar observations were also made at Palermo. These Father Secchi discussed, and it seemed to him that the two series agreed well together, and that the differences observed were too regular and too great to admit of being attributed to errors of observation. He also found that the greater diameter was observed at those times at which the number of spots and protuberances was less. It thus appeared that the action of solar forces actually did change the visible diameter of the sun; but Dr. Auwers has carefully re-discussed Father Secchi's observations, and arrived at an opposite conclusion. He objects to the alleged agreement between the Rome and Palermo observations; and though admitting that both series assign a principal minimum in April 1872, he considers that the general agreement is scarcely more marked than the contrary. A careful comparison also between numerous observations of Bessel and Struve with the solar spot periods does not show any connection. On the whole, therefore, Dr. Auwers considers that it cannot be said that any changes in the sun's diameter, due to agencies upon it, have yet been detected

by the telescope. His paper appears in the *Monatsbericht* of the Berlin Academy for May, and an abstract of it was communicated to the Royal Astronomical Society at their November meeting.—*The Academy.*

TEMPERATURE OF THE SUN.

MR. DEWAR, of Edinburgh, has lately been doing some valuable work, with a view to determining the temperature of the sun, and also to determining the probable fusing and boiling point of the, as yet, infusible element carbon. The paper read by him, although upon neither of these subjects, was somewhat allied to them, and has received Mr. Dewar's attention during their investigation. A supposition of an ingenious nature had been formed, that high temperatures might be measured by observing and registering the length of the spectrum obtained at any particular point, as it is well known that at a comparatively low temperature light of low refrangibility is only emitted, and that the more refrangible rays come into view as the temperature rises. This idea seemed exceedingly well founded, and doubtless would have proved valuable, but that Mr. Dewar finds the human eye is sometimes more and sometimes less sensitive to light of a particular refrangibility, thus precluding it from making trustworthy observations; and, further, the advance in the length of the spectrum is not sharp enough for accurate registering. However, the grant made by the Association for the carrying out of these researches cannot be said to have been of no avail, as Mr. Dewar appropriated it to another investigation, viz. that of estimating the increase in the light of the spectrum as the temperature rises; and in this direction following out Becquerel's idea, he has arrived at the conclusion that, above a temperature of 1,000°, the heat increases as the square of the light.

No one is entitled to more consideration than Mr. Norman Lockyer when speaking upon matters connected with the physical character of the sun; and as the chemistry of the sun must be intimately associated with its present physical condition, any hypothesis coming from him is worthy of a chemist's investigation. Mr. Lockyer's belief is that the sun and stars present to us different stages and degrees of celestial dissociation; that in some of the hotter stars this dissociation is complete, matter existing in its true atomatic state. He believes that at the temperature of the star Sirius, for example, many of the bodies which we here recognize as elements—many of them metals—are decomposed, and that no metalloid or compound exists. A class of stars not so hot as Sirius, in which our sun may be included, although having probably no compounds existing, yet nevertheless have matter in a more complex state, and possess a less quantity of free hydrogen. This class forms the largest class. There is, however, a third division consisting of stars of a lower temperature, such as the

red stars, in which the temperatnre is sufficiently low to allow of higher combinations existing. Mr. Lockyer draws these conclusions from the observation of the spectra of the stars, these spectra gradually increasing in complexity from stars such as Sirius upward; and they also afford internal evidence that the bodies emitting the light are also more complex. Views such as these have been already expressed by some chemists, who have made the primeval earth their especial study; and there seems to be no impossibility or great difficulty in receiving the conception which Mr. Lockyer has now introduced, founded as it is upon physical evidence.—*Athenæum.*

ON THE MOON.

THE *Spectator* thinks that our Moon presents a strange problem for our investigation. It is gratifying to us terrestrials to regard her as a mere satellite of the earth, but in reality she deserves rather to be regarded as a companion planet. She follows a path round the sun which so nearly resembles that pursued by the earth, in shape as well as in extent, that if the two paths were traced down on a quarto sheet it would not be easy to distinguish one from the other. Our earth is simply the largest, while the moon is the smallest of that inner family of worlds over which the sun bears special sway, nor does Mercury exceed the moon to so great a degree in mass and in volume as the earth or Venus exceeds Mercury. Yet the moon, with her surface of fourteen million square miles, seems to be beyond a doubt a mere desert waste, without air or water, exposed to alternations of heat and cold which no living creature we are acquainted with could endure; and notwithstanding her position as an important member of the solar system, as well as the undoubted fact that in her motions she obeys the sun in preference to the earth, she has nevertheless been so far coerced by the earth's influence as to be compelled to turn always the same face towards her larger companion orb, so that not a ray from the earth ever falls upon fully five millions of square miles of the farther lunar hemisphere. A waste of matter here, we might say, and a waste of all the energy which is represented by the moon's motions, did we not remember that we can see but a little way into the plan of creation, and that what appears to us waste may in reality be an essential and important part of the great scheme of Nature.

The influence exercised by the moon on meteorological phenomena has been the subject of a communication to the Academy of Sciences at Paris, by M. Marchand. From examining the distributions of storms between the years 1785 and 1872 he supposes that he detects some relation between the appearance of storms and the age of the moon, and he attempts to show by tables that the moon has an appreciable influence on the temperature and pressure of the air, on the state of the sky and the distribution of rain.

THE APPROACHING TRANSIT OF VENUS.

On November 14 Sir George B. Airy explained to the Royal Astronomical Society the general state of the preparations for the transit of Venus. First, as to the selection of stations. He had originally selected five observing-stations, and in making his choice he had endeavoured to keep in mind what other Governments were likely to do. He had been induced to recommend another station in Northern India for the purpose of taking a series of photographic observations to be used in conjunction with the photographic records to be obtained at the southern stations. As the French would not support the station which he had selected in the Sandwich Islands, by an expedition to the Marquesas Islands, he had found it necessary to recommend to our own Government that there should be two subsidiary observing stations in the Sandwich Islands. The station which had originally been chosen was Honolooloo, at about the middle of the islands; the new stations were to be Ha-wai-i to the east and an island at the western extremity of the group. The three stations would thus be distributed over a distance of some 300 miles—a fact which would greatly add to their chances of fine weather. He had also been considering the propriety of establishing stations at Christmas Island, at Hurd Island, and in Whisky Bay, but at present they knew little of the chances of anchorage or fine weather at these places. The *Challenger* was, however, about to visit and survey them. It would then proceed to Australia, whence the results of their investigation would no doubt be telegraphed to England. As to the selection of stations in the extreme south, the Admiralty would have nothing to do with any station where there was no anchorage, and where there were no human beings. Any station which laboured under both disqualifications must undoubtedly be rejected as unsuitable. He felt himself borne out in this determination by the fact that other nations had adopted the same practical view in their selection of stations. The Astronomer-Royal then enumerated and pointed out upon a globe the stations which had been selected: 8 American, 5 French, 4 German, 19 Russian, and 8 English, besides the private enterprise of Lord Lindsay. He then proceeded to give a description of the now well-known "black drop," which was sometimes described as being so large as to make Venus appear "pear-shaped;" at other times the illegitimate connection between Venus and the limb consisted only of a narrow black strap or band. The Astronomer-Royal had had a working model prepared at Greenwich with a black disc moved by clock-work. The black ligament, or drop, came out as a very marked feature of the contact with the artificial limb. And he hoped that Captain Tupman would be able, from a discussion of the observations of different observers with different telescopes, to determine in what proportion the phenomenon was due to the aperture of the telescope used, and to

what he might call the personal equation of the observer. He then proceeded to explain how when Venus was upon the sun's limb measures are to be made of the common chord of Venus and the limb, and how these measures are affected by the formation of a "black drop" between the two images.—Lord Lindsay then showed some photographs of a model of Venus upon the limb, in which the "black drop" was photographed as a remarkable feature. He pointed out that when the exposure was longest the "black drop" was most marked; and he showed that its size might be greatly reduced by using a stop which only permitted the rays from the central parts of the lenses to reach the plate. Dr. De La Rue said it was quite wonderful to see the amount of preparations which were going forward at Greenwich. It was not right to throw out such insinuations as Mr. Proctor had done about "official obstructiveness."

NEWS FROM THE STARS.

The *Popular Science Review* contains an article by Mr. Proctor entitled "News from the Stars," in which he reviews certain speculations of his regarding the distribution and motion of the stars in space, the accuracy of which recent spectroscopic observation has confirmed. His view is that the stars are arranged in definite systems, the constituent members of which travel through space together. These systems are not conterminous with the constellations, which are often made up of stars not in the same plane at all, and not travelling in the same direction. Nearly four years ago Dr. Huggins showed that the bright star Sirius is travelling away from us at an enormous velocity; and recently he has ascertained that of the seven stars of Ursa Major—the Septemtriones of the ancients—two are moving in one direction and the other five in the opposite direction. The five stars which have the similar motion are consequently regarded as one star-family.

NEW LUNAR TABLES.

At a meeting of the Royal Astronomical Society, a most interesting communication has been read from the Astronomer-Royal, containing a project for a new set of lunar tables, and detailing a few steps which he had already made towards their formation. It is well known that the tables at present in use are those of Prof. Hansen, of Gotha, which were very much more accurate than those of his predecessors. Their author had succeeded in discovering some equations previously unknown, and was able, in forming his co-efficients, to avail himself of a great mass of Greenwich observations, especially those made in recent years with the Altazimuth instrument, which furnished places of the moon at those parts of her orbit, near the conjunction, when it is not practicable to make observations on the meridian.

Although, then, these tables are a great step in advance, yet there is room for further improvement; and the Astronomer-Royal thinks (in which we fully agree with him) that the form in which they are arranged is not well adapted for use, or likely to find permanent acceptance. The late M. Delaunay, of the Paris Observatory, had made further and important developments in the lunar theory, and was understood to be forming a fresh set of tables, when his premature decease cut short his labours before they were completed. In the new scheme just announced by Sir G. Airy, he proposes to base his operations upon the works of his predecessors, particularly of M. Delaunay, the greater part of whose theoretical work he will adopt; but in the actual numerical labour of the formation of tables he hopes to arrange such adaptations as will enable much of it to be done by ordinary computers.

The stupendous work effected by the Astronomer-Royal during his tenure of office in the complete reduction of the observations of his predecessors at Greenwich, from the date of the commencement of accurate observations with good instruments by Bradley in 1750, together with their continuation by himself from 1836, and their extension, as already mentioned, by the use of the Altazimuth from 1847, to parts of the moon's orbit at which she necessarily always escaped observation on the meridian, have furnished the materials for all the important improvements in the lunar theory made by recent investigators. We are sure, therefore, that the whole astronomical world will join us in cordially wishing him success in his scheme now announced for himself making these great works of the fullest practical use by the formation of tables which will supersede all others, and long continue to represent with accuracy the motions of our erratic satellite.—*Athenæum.*

REMARKABLE STAR-SHOWER.

The past year was distinguished by the occurrence of a most remarkable star-shower on the night of November 27 last, to the expected appearance of which astronomers were looking forward with especial attention from the unexplained absence of the double comet of Biela (to which it belongs) from its accustomed returns in the last three of its periodical revolutions. The probability of the comet's path being marked by a meteoric stream into which the earth might plunge on or about November 27 every year was already become a certainty, by the observation of such a meteoric stream on November 30, 1867. On that night M. Zezioli, of Bergamo, observed a distinct star-shower, according to Schiaparelli, no doubt of whose belonging to the missing comet could be entertained. Although the exact date of the shower could not be accurately foretold with certainty from the want of recent observations of the comet, yet every probability of its being seen was favourable

to its reappearance last year, and those who awaited it, as well as many unexpected watchers of meteor-showers, were surprised by the brilliant spectacle which it suddenly presented. At the first approach of darkness on the evening of Wednesday the 27th of November last, the cloudy state of the sky unfortunately deprived observers in the south of England from witnessing the sight; but in Scotland, and north of the Midland Counties of England, many uninterrupted views of it were obtained. On the European continent and in the United States of America, as well as in the East Indies, at the Mauritius, and in Brazil, observers were equally fortunate in recording its appearance; and few great star-showers have hitherto been more satisfactorily observed, or indeed more abundantly described. In an astronomical point of view, the agreement of the time and other circumstances of its appearance with the supposed path of the lost comet is so exact as to prove that the calculations made by astronomers of that comet's orbit cannot be affected by any errors of a large sensible amount, and a proof almost certain is thus obtained that the disappearance of the comet is owing to no unexplained disturbance of its path; but that like some former comets of variable brightness, it has not improbably faded for a time out of view, and that at a future time a reasonable expectation may be entertained of re-discovering it pursuing its original path in repeated visits to the earth's neighbourhood, and to the field of telescopic observation.—*Nature.*

REMARKABLE METEOR.

A VERY remarkable meteor passed over a part of Austria and Saxony on the evening of June 17, the observations of which have been collected and discussed by Professor Niessl, of Brünn, in Moravia. It left a long white streak along its apparent path in the sky, which remained visible for nearly half an hour. The meteor itself appeared to break up, with an emission of sparks and a detonation audible at a considerable distance, about a quarter before nine—after sunset, therefore. The numerous observations made at Vienna, Brünn, Prague, Königgratz (of battle celebrity), and other places, enabled Professor Niessl to determine its real path during the time of visibility with some degree of accuracy. The result was that it was, when first seen, vertically above a place a little to the south of Chrudim, in Bohemia, at a height of about 35 English miles, and, at its dissolution, nearly vertically above a village called Hernnhut, in Saxony, at the height of about 18 miles. Particular inquiry was made at the latter place, but nothing was heard of any fragments being found, only some non-scientific persons stated that the meteor appeared to have burst in a north-easterly direction. It would appear, however, from a newspaper report, that before the final burst some fragments fell at Proschwitz, near Reichenberg, were some pieces were found nearly of the

size of a fist, burning with a blue flame, and emitting a sulphureous smell; the detonation there was loud, and compared to the firing of distant cannon. The general course of the meteor was from south-south-east to north-north-west; and it was seen at different places along a path occupying altogether an extent of about 80 miles.

PERIODICAL COMETS.

THE Periodical Comets of Brorsen and Faye have been re-found by M. Stéphan, at Marseilles. The former was detected by him on the night of September 1, the latter on that of September 3, both at about 4 o'clock (civil time) on the following mornings. Of Brorsen's his description is that it "has the appearance of an ovoid nebulosity, diffused, of an excessive faintness, with a trace of condensation towards the *central part*; the observation very difficult." This body was first discovered by Brorsen, at Kiel, on February 26, 1846, and some interesting observations of it were made at the last appearance in 1868. On the present occasion it will be in perihelion about October 10, but was nearest the Earth (about 100,000,000 of miles) on the 10th of this month (September). Faye's comet was first discovered by M. Faye, at Paris, on November 22, 1843, and has been seen at every return to perihelion since, in 1851, 1858, and 1866, but always very faint. M. Stéphan described it, when recently seen by him, as "excessively faint, very small, but with a very distinct (*bien net*) little nucleus, which renders the observation easy."

DANGER FROM LIGHTNING.

AN American gentleman who has been figuring up the chances of being struck by lighting arrives at the following re-assuring results. Taking the figures of the last census reports, we find that during the year 1870 there were, in the whole country, 202 deaths from lightning-stroke. Let womankind take notice that, out of these, 148 deaths were of males, and only 54 of females. The total number of deaths from all causes was nearly 500,000. There were 2,437 deaths from other causes to one death from lightning, and there were 190,883 persons living to every one killed by this cause. It is somewhat singular that the lightning was decidedly more destructive with both males and females between the ages of 10 and 30 years than with any others; between 10 and 15 years is the most fatal time, but even then the number is very small. Much comfort for those still inclined to be timorous is to be found in going back further on the record. The deaths by lightning in 1870 were only 11 more than in 1860, while the population had increased more than 7,000,000, and the rate is declining, in spite of the hasty conclusions formed by reading the news of a day.

In 1860 there were 48 deaths by lightning out of every 100,000 deaths from all causes; in 1870 the rate was only 42. But now, while only 202 persons died from lightning-stroke in 1870, there were 397 deaths from sunstroke, or nearly twice as many. Yet the number of persons who shudder when they see the sun rise would bear a very small ratio to those who shudder at the rising of the thunder cloud. The rate of deaths by sun-stroke has declined during the decade from 91 to 81 in 100,000 deaths from all causes, and, with the increase in care and information on the subject, is likely to decrease still more, but it will always probably be largely in excess of the lightning-rate. It is also noticeable that there were 1,345 deaths by suicide, while there were only 202 deaths by lightning—in other words, an individual is six times as likely to kill himself as lightning is to kill him.—*London Medical Record.*

LIGHTNING-RODS.

The *Journal of the Franklin Institute* has published a series of articles by Mr. John M. Mott on Lightning. The writer comes to the following among other conclusions:—"Lightning-rods, as usually erected, do not afford much protection." "The conducting power of Lightning-rods is proportional to their solid contents, and not to their surfaces." "Insulators are of no use in any case." "The rod must be attached directly to the building, the closer the better." "Sharp points for the upper terminations of rods are necessary; rods are of but little value without them."

ST. PAUL'S AND THE LIGHTNING.

Although much had been done to protect St. Paul's Cathedral, recent examination showed that it was in a very dangerous condition. Upon the report of Mr. John Faulkner, Associate of Telegraph Engineers, of Manchester, the authorities commissioned him to prepare a plan for the fitting of the cathedral with an efficient system of conductors. The plan submitted was approved, and the fitting is now completed. In metallic connexion with cross and ball, and scrolls, are eight copper conductors, each being a half-inch strand of copper wires. The octagonal strand has been adopted as giving most metal in the least space. These eight conductors then pass to the metallic railing of the Golden Gallery, with which they are in metallic connexion. Thence they are carried down to the dome, to the metallic surface of which they are again connected at several portions of their length; then down the rainfalls, over the leaden roofs of the aisles, in the angles formed by the aisles themselves; again down the rainfalls to the sewers. Further, the choir and nave roofs are connected together by a saddle or conductor stretching over them both,

and joined to the conductors proceeding from the summit of the west towers. Even this, it is said, did not satisfy Mr. Faulkner, who tested, sheet by sheet, the electrical condition of the leads, connecting the worse insulated sheets by copper bands to the better conducting surfaces. Thus the dome, aisle-roofs, and ball and cross, and the two west towers, form one immense metallic conductor, and the danger arising from interior gas-piping is removed; for it is proved that electricity accumulates upon the surface only of bodies. In the sewers, which always afford a moist earth connexion, the copper strands are riveted to copper plates, and these again are pegged into the earth. By this means as good an earth connexion is obtained at the top of the cross, at the very summit of the cathedral, as is found in the sewers at its base. The misfortune is, that if another electrician were sent to-morrow to report on the condition of the cathedral, he would, doubtless, show that it was full of weak points. However, we must trust to Mr. Faulkner, who seems to have gone into the subject very carefully.—*Builder*.

WIND-INDICATORS.

In a communication to the Académie des Sciences, M. Tany objects to vanes as indicators of the wind, since they indicate a direction when there is no wind, and they do not indicate the force or velocity of the wind. He would substitute a little flag suspended by a cord from a metallic ring pulleyed on a vertical rod.

NORTH ATLANTIC HURRICANE.

A paper has been read to the Meteorological Society, "On the North Atlantic Hurricane of August 20 to 24, 1873, which did much damage at Halifax, Nova Scotia, and elsewhere," by Capt. H. Tonybee. The author alluded to various data which had come into the Meteorological Office respecting this gale, especially to a chart of its track, and important remarks from Mr. J. R. Macfarlane. This data proved that it was a hurricane, and its route was traced from a position to the south-east of Bermuda to Halifax, showing its probable track for four days. The author then went on to say that if the circular theory for hurricanes were correct, little more could be done, though it would be very interesting to trace so hard a gale from its formation to its breaking up. But he said if Mr. Meldrum's "Notes on the Form of Cyclones in the Southern Indian Ocean" were correct, then it was incumbent on the meteorologists of the northern hemisphere to institute a similar inquiry, as the form of cyclones in the southern hemisphere worked out from facts by Mr. Meldrum made it necessary to modify the rules in use amongst seamen for avoiding their centres. An enlarged copy of Meldrum's diagram (reversed, to adopt it to the northern

hemisphere) was exhibited. The paper concluded with a suggestion that the August gale of 1873 would afford the means for inquiry into the shape of the northern hemisphere cyclones, and that data for that month should be collected from all parts of the North Atlantic, and worked up into daily synoptic charts, which suggestion the author hoped would be carried out either by America or England.—*Athenæum.*

CYCLONES.

A COMMUNICATION has been made to the "Academia dei Lincei" of Rome, by M. Tarry, giving the results of his personal experience and investigations into the connection between the cyclonic storms and the showers of sand that frequently visit Southern Europe. M. Tarry, after travelling as Secretary to the French Meteorological Society into Northern Africa and the Desert of Sahara, and having consulted the files of the *Daily Weather Bulletin* of the Paris Observatory, believes himself to have established the fact that whenever a cyclone passes southward from Europe over the Mediterranean Sea into Africa (as some few of them do every season), it then returns northward or northwestward, and transports the sand which in the desert formed a sand-storm to the southern coasts of Europe as a sand-shower of greater or less duration.

METEOROLOGY OF INDIA.

FOR some years past meteorological observations have been regularly made at many places throughout the length and breadth of India, chiefly by native observers, under the direction of the local European authority, usually the surgeon, and these observations have been published, and distributed to many parts of the world. Meteorologists have made use of them in their discussions about the climate of India, and in their general theories of the weather. What will they say when they hear that the observations are worthless? Yet such is the fact: a recent discovery having demonstrated that in Bengal (and in an adjoining Presidency) the native observers, loving ease better than duty, had for years been in the practice of sending in false returns. In some instances the figures of one year were deliberately re-copied and handed in as the register for succeeding years. Consequently the long series of observations will have to be carefully expurgated before they can be turned to profit in meteorological science.—*Athenæum.*

MAURITIUS OBSERVATORY.

IN the Report of the Council for the year, presented by Capt. Douglas Galton, it was stated that in accordance with a resolution passed at Brighton last year, the Council urged upon

the Colonial Office the expediency of affording such pecuniary aid to the Mauritius Observatory as would enable the director to continue his observations on the periodicity of the cyclones. An intimation has been received from the Government that an inquiry into the condition, size, and cost of the establishment of the Observatory is now being conducted by a special Commissioner from England, pending which inquiry no increase of expenditure upon the Observatory can be sanctioned; but that when the results of the inquiry should be made known, the Secretary for the Colonies will direct the attention of the Governor to the subject. The Council have not deemed it necessary to take any action on the resolution passed at Brighton in reference to the Botanical Establishment at Kew. A third resolution passed at Brighton related to the observation in India of the Transit of Venus in 1874. The result of communications with the India Office on the continuation of solar observations in India is that a photo-heliograph and other instruments are in course of preparation for these objects. The Council were reminded that there are in the three Provinces of India Government officers engaged from time to time in recording observations of this nature. A Committee was appointed at Exeter, in 1869, on the laws regulating the flow and action of water holding solid matter in suspension, and the Indian Government have offered 2,000*l*. to enable experiments to be carried on.—*Ibid.*

THE NEW YORK OBSERVATORY.

The Report of the Director of the New York Meteorological Observatory is before us. The points considered in this Report are: 1. Has the summer temperature of the Atlantic States undergone any modification?—The general conclusions are, that there has been no change. 2. What is the direction in which atmospheric fluctuations cross the United States?—The general conclusions are, that atmospheric disturbances cross the United States in a direction towards the east, the cold wave from about W.N.W. to E.S.E., and the warm wave from W.S.W. to E.N.E. 3. Is it possible to trace the passage of American storms across the Atlantic and predict the time of their arrival on the European coast?—The answer is, Yes; out of eighty-six atmospheric disturbances expected to cross the Atlantic, only three seemed to have failed. These results are of considerable interest and importance.

THE METEOROLOGICAL SOCIETY.

The Annual General Meeting of the Meteorological Society was held at 25 Great George Street. Dr. R. J. Mann, president, in the chair. The date of the annual meeting having been altered in June last to January, the Report of the Council was shorter than usual. The earlier portion of the Report dealt

principally with the various alterations made at the Society's library at 30 Great George Street, and with the efforts which the Council have been making to render the operations of the Society more extended and rest upon a broader basis than heretofore. The Council took advantage of the presence of their foreign secretary, Mr. Scott, as one of the delegates from this country at the Meteorological Congress at Vienna, to request him to represent the Society. The Congress was duly held from the 1st to the 16th of September, when Mr. Scott presented a Report on the replies received in answer to a series of questions which the Council issued to the Fellows on several important points in connection with the hours of observation, instruments, &c., and which has been printed in the Report of the Congress. The Report concluded by stating that the Council have to mark with some measure of satisfaction the maintenance of the numbers of the Society during a somewhat critical and transitional period in its history; when changes of detail have been entered upon with a view to increased energy of action, and when the beneficial results of the alterations have not yet had time to be practically felt.

The President then delivered his address. After alluding to the loss which the Society had recently sustained in the death of Mr. Beardmore, and marking the place that gentleman had filled as President at the transition era of the Society's history, the President drew attention to a misconception that is largely entertained of the primary aims of meteorological science, and pointed out that, desirable as a comprehensive and reliable theory is, the immediate object of observational work is none the less certainly the determination of climate in different regions of the earth, and the investigation of the method by which the action of the great natural forces that determine temperature, direction and force of wind, and rainfall, is influenced by physical conditions. The argument was supported by evidence of the valuable practical results that are secured in these particulars by the labours of meteorologists.

The address then proceeded to note briefly the chief landmarks that had marked the yearly progress of meteorological science since the period of Mr. Beardmore's presidency, when the Society, in its remodelled form, had just reached the half-way stage of its history. From this review it appeared that the photographic method of record has been largely extended, that the discussion of the Greenwich observations from 1848 to 1868 is being steadily pursued; that the influence of meteorological conditions upon the public health is carefully investigated in the metropolitan district; that telegraphic intercommunication of meteorological aspects is now regularly made throughout the United States of America, and from the Meteorological Office in London through England, and through France to the shores of the North Sea and Baltic in one direction, and to Corunna in the other; and that storm warnings are displayed, and fishermen's

barometers maintained, at 129 coast stations. The methodical investigation of the connection of sun-spot periods with atmospheric phenomena, such as rainfall, aurora, magnetic storms, and earth currents, was also alluded to. Among other topics of special interest connected with the recent progress of meteorological science, the President dwelt, with especial favour, upon the discovery and establishment of Buys Ballot's Law, and Mr. F. Stevenson's Barometric Gradient; the extension of the influence which indicates this law to the great vertical circulation of the oceans, traced out by Dr. Carpenter and Professor Wyville Thomson, the marine charts, and especially the mapping out of the mid-Atlantic area; of the Doldrum calms by Captain Tonybee; Mr. Meldrum's Mauritius investigations of the movements of cyclones of the Indian Ocean, the daily weather-charts of the Meteorological Office; Mr. Symons's examination of the rainfall of the British Islands, with a volunteer staff of nearly 1,700 observers systematically distributed; Mr. Draper's deductions as to the invariability of the climate of the United States, and to the orderly progress of storms across the entire breadth of the Atlantic; the establishment and work of International Meteorological Conferences, and the barometric compensation of clock rates for altering pressures and resistances of the atmosphere.

RADIATION OF HEAT FROM THE MOON.

At the Royal Institution, in a discourse read by the Earl of Rosse, F.R.S., it was stated that during the course of the year 1868 an arrangement was prepared for measuring the Heat in the image of the Moon, formed by the mirror of the 3-foot reflector at Parsonstown. For the purpose of further concentrating the heat of this image of 2·9 inches mean diameter on to the face of a thermopile ⅓rd of an inch diameter, a concave mirror of 3½ inches diameter and 3 inches focal length was employed. To secure greater steadiness of the needle than was otherwise obtainable, a second similar concave mirror and thermopile were placed by the side of the first, the similar poles of the thermopiles being connected with each other, and the others with the terminals of the galvanometer. Thus, the deviations due to the Moon's heating effect were proportional to the *sum* of the effects due to each pile separately, and those arising from disturbing causes, acting on the two piles, to the *difference* of the effects due to each pile. To secure still greater steadiness of the needle, the two piles of four pairs each, which, having been made at *different* times by Messrs. Elliott, not of equal power, were replaced by two more equal thermopairs constructed on the spot. The apparatus was enclosed on all sides, except on that towards the mirror of the telescope, with a box of tin and glass, and the lattice-tube was covered with a cloth to keep draughts of air from the piles. Two covered wires led from the thermopiles to

the galvanometer in the observatory, and the heating effect was determined by directing the telescope so that the Moon's image fell alternately, for the space of one minute, on each of the two small concave mirrors.

The observations made during the seasons 1868–9 and 1869–70, were found to follow pretty well Lambert's law for the variation of light with phase. It was found also that a piece of glass which transmitted 80 per cent. of the Sun's rays suffered only about 10 per cent. of the Moon's rays to pass through; thus a large amount of absorption before radiation from the Moon's surface was shown to take place.*

In the earlier experiments no attention had been paid to the correction to be applied for absorption of heat by the Earth's atmosphere; but, as the apparatus was gradually improved, it became indispensable to determine the amount of this correction before attempting to approach more nearly to the law of variation of the Moon's heat with her phases than had been done in the earlier investigation.

By taking long series of readings for lunar heat through the greatest ranges of zenith distance available, a table expressing the law for decrease of heat with increase of zenith distance, closely following that deduced by Seidel for the corresponding decrease of the *light* of the stars, was obtained. By the employment of this table, the determinations of the Moon's heat at various moments of the lunation were rendered comparable and available for laying down a more accurate "phase-curve" than had been previously obtained. This curve was found to agree more nearly with Professor Zöllner's law for the Moon's light, on the assumption that her surface acts as if it was *grooved* meridionally, the sides of the grooves being inclined at the uniform angle of 52° to the surface, than with Lambert's law for a perfectly *smooth* spherical surface.

The distribution of light on two white globes, constructed in accordance with Lambert's and Zöllner's hypotheses, on which a beam from the electric light was thrown, was shown to be very different in the two cases; the brightest spot on the former being at the centre, and on the latter at 52° on each side from the centre at the time of Full Moon, and at other times on the former at

* Assuming Wollaston's estimate of 800,000 : 1 to be the correct value of the proportion between sunlight and that of Full Moon, and the percentage of heat transmitted by glass to be 10 per cent. for the Moon's rays and 80 per cent. for the Sun's (the difference being due to absorption before radiation from the Moon's surface), the corresponding ratio for solar and lunar heat deduced was 80,000 : 1. The later observations on lunar heat would require some modifications of this value, but in the present uncertainty as to the value for the proportion between sunlight and moonlight for which

Wollaston gives the value	801,072
Bouguer „	300,000
Bond „	470,980
Zöllner, 1st method „	688,000
„ 2nd „	619,000

further examination of the question would appear unprofitable.

the bright limb, from which it gradually decreases towards the terminator; while on the latter there is a rapid decrease from the bright limb to a minimum about half-way to the terminator, after which it increases again, and then fades away on approaching the terminator.'

On examining the phase-curve which had been obtained, a certain want of symmetry on the two sides of Full Moon was perçeived, which was ascribed to the unequal distribution of mountain and plain on the lunar surface, as was shown by a rough diagram of the lunar surface with its so-called "seas." It had also been found that the percentage of the Moon's heat transmitted by a sheet of glass diminished from 17·3 per cent. at Full Moon to about 13·3 per cent, at 22½°, 11 per cent. at 45°, and 10 per cent. at 67½° distance from Full Moon; a circumstance which might have been accounted for by supposing that there is a constant amount of radiant heat coming from the Moon in addition to that which, like the light, varies with the phase, had it not been found that as the Moon approached tolerably near the Sun, as for instance, on March 27, 1871, when her distance from full was 138°, no perceptible amount of heat radiated from her surface.

The less rapid decrease of the Moon's heat than of her light on going farther from Full Moon, and the increase of percentage of heat transmitted by glass towards the time of Full Moon, may probably be explained on the assumption that when the Sun's heat and light strike the Moon's surface, the whole of the former and only a certain proportion of the latter, depending on the intrinsic reflecting power or "Albedo" of the surface, leave it again, and consequently the shaded portions, which are inclined more towards the position of the Earth at Quadrature than at Full Moon, reflect a larger amount of heat as compared with the light at the former than at the latter time, and a greater flatness of the heat- than of the light- phase-curve is the result.

With the view of obtaining a decisive result on the question, whether or not the Moon's surface requires an appreciable time to acquire the temperatures due to the various amounts of radiant heat falling on it at different moments, simultaneous determinations of the amount of the Moon's heat and of her light were made, whenever the state of the sky allowed of it, during the Eclipse of November 14, 1872. The Eclipse was a very partial one, only about $\frac{1}{40}$th of the Moon's diameter being in shadow; but although this circumstance, coupled with the uncertain state of the sky, rendered the observation far less satisfactory than it would otherwise have been, yet it was sufficient to show that the decline of light and heat as the penumbra came over the lunar surface and their increase after the middle of the Eclipse were sensibly proportional.

Rather with the view of finding the value of the galvanometer readings in terms of the radiation from a surface of known

temperature, and capable of being reproduced by anyone at any future time, than in the expectation of getting more than the roughest approximation to the temperature of the lunar surface, readings of the galvanometer were taken when the faces of the piles were alternately exposed for periods of one minute to the radiation from two blackened tin vessels filled with water of different temperatures. It was thus found that were the atmosphere removed, the surfaces of New and Full Moon might be respectively replaced by blackened tin vessels of equal apparent area to that of the Moon, and at temperatures of 50° and 247° Fahrenheit.

In conclusion, Lord Rosse expressed a hope that among the many subjects which engage the attention of astronomers that of radiation of heat from the Moon might not be entirely lost sight of, more especially by those who live in a more favourable climate for such observations than that of the British Isles.

In a communication from Lord Rosse to the Royal Society, it was stated "Lord Rosse is of opinion that the difference between the radiation of the New and the Full Moon may be set down at about 200 degrees." Lord Rosse writes further:—"The heating effect produced by the Full Moon on the apparatus on its being turned from an adjacent part of the sky towards the Moon at Full was equal to that which would result were the Moon and sky respectively replaced by two blackened tin vessels of hot water whose apparent diameters are equal to that of the Moon, and whose temperatures differ by nearly 200 degrees Fahrenheit. It is left to others to form the best estimate they can of the allowance which should be made for the probable inferiority in emissive power of the Lunar surface to that of lampblack, which is the most powerful mediator known, and surpasses polished metal in the proportion of 100 to 14."

The President of the Astronomical Society, Prof. Cayley, has read his address, on the presentation of the gold medal of the Society to Prof. Newcomb, of the United States Navy, in recognition of the great value of his mathematico-astronomical works, especially the Tables of the planets Uranus and Neptune. He took the opportunity of describing the principles on which these had been based, pointing out the nature of the theoretical work involved, which had thus been made of the fullest practical utility, and mentioning the desideratum which, especially in the case of Uranus, had been supplied by the skilful and laborious exertion of Prof. Newcomb. But Prof. Cayley did not omit also to refer to his other important contributions to mathematical astronomy, particularly on the subject of the Lunar Theory.

METEOROLOGY OF 1873.

Monthly Means of Results for Meteorological Elements at the Royal Observatory, Greenwich, in the year 1873.

1873 Months	Mean Reading of the Barometer	Temperature of the Air: Highest	Lowest	Range in the Month	Mean of all the Highest	Mean of all the Lowest	Mean daily Range	Mean Temperature
	In.	°	°	°	°	°	°	°
Jan. .	29·676	53·8	26·0	27·8	46·8	38·0	8·8	42·1
Feb. .	29·901	50·1	25·0	25·1	39·2	30·8	8·4	34·3
March	29·623	64·6	27·2	37·4	51·3	35·2	16·1	41·9
April	29·832	76·8	28·7	48·1	57·1	37·9	19·5	45·9
May .	29·795	70·9	34·0	36·9	62·3	42·5	19·8	50·6
June .	29·794	81·2	42·0	39·2	70·2	51·0	19·2	58·9
July .	29·793	88·7	46·4	42·3	76·6	53·9	22·7	63·4
Aug. .	29·765	87·3	47·9	39·4	71·7	54·4	20·3	62·7
Sept. .	29·792	72·5	38·2	34·3	65·2	46·1	19·1	54·7
Oct. . .	29·685	75·1	26·7	48·4	57·0	40·6	16·4	47·8
Nov. .	29·708	57·0	25·8	31·2	50·1	38·8	11·3	44·2
Dec. .	30·107	56·3	22·1	34·2	45·6	35·2	10·4	40·6
Means	29·780	69·5	32·5	37·0	58·0	42·0	16·0	48·9

1873 Months	Mean Temperature of Dew Point	Mean Elastic Force of Vapour	Mean Weight of Vapour in a Cubic Foot of Air	Mean Additional Weight required to saturate a Cubic Foot of Air	Mean Degree of Humidity (Saturation=100)	Mean Weight of a Cubic Foot of Air	Mean Amount of Cloud 0-10	Number of Rainy Days	Rain: Amount collected on the ground: Gauge read daily	Gauge read monthly
	°	In.	Grs.	Grs.		Grs.			In.	In.
Jan. .	38·2	0·231	2·7	0·5	87	546	6·9	15	2·45	2·48
Feb. .	30·3	0·169	2·0	0·4	85	561	9·2	11	1·93	1·82
March	36·2	0·231	2·6	0·4	87	547	6·5	15	[illegible]33	1·42
April	38·9	0·237	2·8	0·8	78	546	6·5	12	0·61	0·50
May .	43·7	0·285	3·3	0·9	78	540	7·0	12	1·49	1·46
June .	52·1	0·389	4·3	1·3	79	531	7·2	11	2·56	2·58
July .	54·9	0·431	4·8	1·7	74	526	6·0	9	1·85	1·90
Aug. .	54·4	0·424	4·7	1·6	75	527	6·3	14	3·18	3·28
Sept. .	49·0	0·348	4·0	0·8	81	536	5·6	10	2·52	2·10
Oct. . .	44·2	0·290	3·3	0·5	88	542	6·9	14	2·55	2·79
Nov. .	40·3	0·250	2·9	0·5	86	546	7·4	15	2·58	2·70
Dec. .	37·6	0·225	2·6	0·4	90	558	7·2	6	0·31	0·33
Means	43·5	0·293	3·3	0·8	82	542	6·9	144	23· 6	23·86

1873 Months	Wind, From Osler's Anemometer: Number of Hours of Prevalence of each Wind referred to different Points of Azimuth: N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Number of Calm or nearly Calm Hours	Mean Daily Pressure in lbs. on the square foot	From Robinson's: Mean daily Horizontal Movement of the air in Miles
Jan. .	10	21	63	45	103	359	86	20	37	0·78	413
Feb. .	126	166	37	41	8	40	51	58	142	0·45	281
March	55	150	156	39	54	122	71	18	79	0·45	295
April	123	258	64	46	12	65	69	72	11	0·30	291
May .	120	135	55	16	35	149	142	84	8	0·27	270
June .	72	100	35	42	42	190	140	42	17	0·21	251
July .	13	3	15	29	76	370	194	22	23	0·25	264
Aug. .	6	8	32	26	42	384	190	36	20	0·27	284
Sept. .	66	53	39	64	43	191	192	36	36	0·26	250
Oct. . .	72	66	18	28	79	306	125	30	0	0·25	227
Nov. .	25	108	175	56	79	132	101	44	0	0·49	296
Dec. .	26	20	12	29	79	292	244	20	22	0·26	247
Means / Sum	713	1108	701	464	652	2600	1645	488	395	0·35	282

(Sum: totals for Number of Rainy Days, Rain and the Wind hour columns.)

Explanation.—The cistern of the barometer is about 160 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of corrections from Mr. Glaisher's paper in the *Philosophical Transactions*, Part I., 1848; and from the readings of the wet and dry bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11 to 16 are calculated by means of Glaisher's *Hygrometrical Tables. Fifth Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of a column of mercury which balanced the whole weight of atmosphere of air and water: the numbers in column 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air.

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE, ART, AND LITERATURE, 1872.

PROFESSOR DE LA RIVE. M. De La Rive's discoveries in science, and more particularly electricity, acquired him a European reputation, and by the political world of this country he was, not many years ago, known and appreciated during his short diplomatic career, when, in a moment of great emergency and apparent danger to his country, the Swiss Confederation intrusted him with an important mission to Great Britain. Born at Geneva, in 1801, of an aristocratic family, closely related to Cavour, living in affluence among the distinguished scientific and literary circle of that city, De la Rive had scarcely completed his academical studies when, at the age of twenty-two, he was called to the chair of natural philosophy, and took his seat among the Pictets, the De Candolles, and Provosts of that day.

De la Rive's high scientific reputation is, as is well known, principally due to his discoveries in electricity; but electricity is far from being the only subject which fell under his investigation. His first researches were on the subject of heat. From 1825 to 1827 he published, conjointly with his friend and colleague, Professor Marcet, several papers on the determination of the specific heat of the simple and some of the compound gases by the method of cooling, and in 1828 he took advantage of a perforation extending to the depth of above 700 ft. in search of an Artesian well, to undertake, conjointly with the same friend, a series of experiments on the temperature of the interior of the earth. They constitute, as we believe, the first accurate results obtained on that subject; for Poisson, the celebrated French mathematician, adopted them as a basis from which he proceeded to deduce his well-known calculations on the temperature of the earth's crust.

But De la Rive, as we have said, was above all an electrician, and it is no doubt to his discoveries in that science that his great reputation is principally due. Scarcely more than half a century ago electricity was comparatively in its infancy, occupying at most a chapter or two in the treatises of physics of that period. It has now become a vast science, and there are few of its branches to the advance of which De la Rive has not more or less contributed. His researches in 1825 and 1826 on the chemical theory of the voltaic battery and on the properties of magneto-electric currents, prepared the way to future discoveries. Electro-dynamics, magnetism, the relations of magnetism with dynamic electricity, the propagation of electricitity through the interior of bodies, the nature and properties of the voltaic arc, and the consideration of the various sources from which electricity is derived, are subjects which have all successively occupied his

attention. At a later period De la Rive directed his mind more particularly to the phenomena which accompany the passage of electric currents through extremely rarified media. The results he obtained led him to a new theory on the cause of the aurora borealis; and when this theory was contested by some, he demonstrated its plausibility by exhibiting before a select audience at Paris, composed principally of members of the Institute, a series of beautiful experiments, producing by artificial means the various principal phenomena which characterise the aurora.

Besides these original researches, De la Rive published, between 1853 and 1858, a complete treatise on electricity and its recent wonderful applications, in three large octavo volumes, which, though not intended for a popular treatise, is comprehensible to all who have received a reasonable amount of scientific culture. This interesting work was immediately translated into English by Mr. Charles Walker, F.R.S., and both in France and in this country is still considered as one of the most complete treatises on this branch of physical science.

One of the most interesting of De la Rive's discoveries, and which soon became eminently practical, particularly in this country, appeared in a memoir published in 1840, in which he first brought to light the results he had obtained by applying the electric force in a direct manner to the gilding of silver and brass. De la Rive did not hesitate to make this discovery public, by communicating it at once to the Académie des Sciences, and thereby forfeiting all personal interest in its future application. His process, which was still imperfect for general use, was soon after taken up by Messrs. Elkington and Roulz, and through their improvements rendered capable of replacing in a great degree mercurial gilding. It was on the occasion of this discovery that the great prize of 3,000f. was awarded to De la Rive by the French Institute.

It is hardly necessary to add that the highest scientific honours Europe can bestow were showered on De la Rive. He became member or correspondent of almost every scientific society in Europe. About 1840 he was named Correspondent of the French Institute, and in 1846 Foreign Member of our Royal Society. Finally, in 1864 he attained the highest honour to which a man of Science can aim, by being nominated one of the eight Foreign Associates of the French Académie des Sciences.—Abridged from the *Times*.

Dr. Crace Calvert, F.R.S., F.C.S. The illness which caused Dr. Crace's death was contracted at Vienna, whither he had gone to act as juror in the International Exhibition. The *Journal of the Society of Arts* furnishes some particulars concerning the work of Dr. Calvert. As an analytical chemist his renown was European. He left England as a youth to pursue his education in France, and in the schools of that country secured many honours by the awards which he obtained. He subsequently pursued the study of chemistry, and was appointed

assistant chemist at the Gobelin works, under his learned master, Chevreul. Soon after his return to England he commenced reading a series of papers before the Society of Arts on chemistry applied to industry. At a later date, when the Society of Arts proposed to establish Cantor lectures, he gave the proposition his hearty support, and delivered two courses of lectures on 'Chemistry applied to the Arts.' He also delivered courses on 'Synthesis and the Production of Organic Substances,' on 'Aniline and Coal Tar Colours,' and on 'Dyes and Dye-stuffs other than Aniline.' In 1846 he settled in Manchester, and was soon after appointed Professor of Chemistry at the Royal Institution there. He was also for some time a lecturer at the Manchester School of Medicine. His connection with the Manchester Sanitary Association led him to hygienic investigations—one of the principal results of which was a patent for the application and preparation of carbolic acid. In scientific circles great interest attached to Dr. Calvert's protoplasmic investigations, some of the results of which were communicated in a paper read at the meeting of the British Association in Edinburgh some years ago, and afterwards published in the Transactions of the Royal Society. Dr. Calvert was a Fellow of the Royal Society England, a fellow of the Chemical Society, and an honorary Fellow of the Chemical Society of Paris.

PROFESSOR J. A. F. BREITHAUPT, of Freiberg, the well-known Mineralogist.

CAPTAIN SIVERT TOBIESON, the distinguished Norwegian Arctic Explorer, died from scurvy on the Novaya Zemlya Coast.

B. F. DUPPA, F.R.S., well known for his numerous and important researches in organic chemistry. He was educated at Cambridge, and was afterwards, in the year 1857, a pupil in the Royal College of Chemistry. Within a period of eleven years he published, partly alone and partly in conjunction with Mr. W. H. Perkin and Dr. Frankland, no less than twenty papers, most of which appeared in the Transactions and Proceedings of the Royal Society. The most important of these researches related to the action of bromine and iodine on acetic acid, the artificial production of tartaric acid, the formation of organic compounds containing mercury, and the synthetical production of numerous acids of the fatty and acrylic series. Mr. Duppa was elected a Fellow of the Royal Society in 1867. Being a man of independent means, he never applied for, nor held, any scientific appointment, but formed one of that small band of enthusiastic and disinterested amateur workers of whom England may justly feel proud, and to whom she is so much indebted for a very large proportion of the contributions which she has made to the progress of science.—*Nature.*

ADAM SEDGWICK, Emeritus Woodwardian Professor of Geology in the University of Cambridge. Professor Sedgwick was born at Dent, in Yorkshire, in June 1784, or, according to

another account, in 1785–86. In due course he was entered at Trinity College, Cambridge, where he took his Bachelor's degree in 1808, being fifth Wrangler. In 1810 he was elected to a Fellowship in his College, of which at his death he was the Senior Member. In 1818 he succeeded Professor Hailstone in the Chair of Geology founded at Cambridge by the celebrated Dr. John Woodward. He also became a Fellow of the Geological Society of London, and was elected to its Presidential Chair in the years 1829-30-31, and twice delivered the customary address as President.

Fifty-five years ago, when Adam Sedgwick first assumed the professorial gown, little was known in England of geology as a science. Notwithstanding, indeed, the writings of Werner, Hutton, playfair, and William Smith, only the keynotes of geological science had been as yet touched.

Sedgwick's first acknowledged publication was a paper on the physical structure of the Devonshire and Cornish formations, read before the Cambridge Philosophical Society in 1820. Even at that time he saw that the Plymouth fossil corals could not be identified with those of the mountain limestone, and were of necessity of earlier date. Fifteen years later we find him again occupied with the geology of Devonshire, and (in conjunction with the late Sir Roderick Murchison) reading before the British Association at Bristol a paper on the Culmiferous strata between Dartmoor and the north-western coast of Devonshire, and pointing out for the first time the true geological position of those deposits. In June 1837, these two eminent men conjointly gave to the Geological Society their account of the district. In 1838 Professor Sedgwick re-surveyed the country south of Dartmoor, and in the following year we find him, in concert with Sir Roderick Murchison, adopting the final classification of the older sedimentary rocks of our two south-western counties.

In 1851 the Council of the Geological Society awarded to Professor Sedgwick the Wollaston Palladium Medal "for his original researches in developing the geological structure of the British Isles, of the Alps, and of the Rhenish Provinces."

No member of the University ever laboured in a higher degree than the late Professor to elevate the character of Cambridge as a school of the Natural Sciences. Indeed, it is scarcely known to the world how much his care and liberality contributed towards the work of providing for the now large collections of the Cambridge Geological Museum, of which Dr. Woodward's cabinet formed the original nucleus. In his "Synopsis of the Classification of the British Palæozoic Rocks" the late Professor Sedgwick expressed his matured views, and gave his final decision on the classification and nomenclature of the older palæozoic formations, giving to the Silurian system of Sir Roderick Murchison all the lower palæozoic formations above the Coniston grits, inclusive, down to the Skiddaw slate, and its equivalents, the Bangor and Longmynd group, the most

ancient of British rocks. The Professor was the author, jointly with Mr. W. Peile, of two papers printed in the Transactions of the Geological Society, upon the coal-fields, &c., of Cumberland; of ten other papers, jointly with Sir Roderick Murchison, on the stratification of Devon, Cornwall, the Eastern and Austrian Alps, and on the Silurian and Cambrian Systems; these are to be found in the Transactions of the Geological Society and the Reports of the British Association. He also contributed single-handed more than 30 other papers and memoirs; the full list of these, with titles, &c., may be found in Agassiz's *Bibliographia Zoologiæ et Geologiæ*.

As a lecturer, Professor Sedgwick's style was clear, earnest, philosophical, and full of energy; and even when nearer 90 than 80 years of age, he was as full of humour and anecdote as in middle age.

The late Professor was a Canon of Norwich Cathedral, and acted for many years as Secretary to the late Prince Consort in his capacity as Chancellor of the University of Cambridge. He was also the reputed author of an elaborate article in the *Edinburgh Review* upon the *Vestiges of the Natural History of Creation*.

LOUIS RUDOLPH AGASSIZ. Prof. Agassiz (says the *New York Tribune*) was simple in dress and mode of living. His figure was somewhat under the medium height; his massive head, slightly inclined forward, rested on a thick-set and sturdy frame; the natural expression of his face was of cordiality and good humour; his large eyes of bluish gray were ever ready to brighten with kindly interest when a student was seeking information, or telling of what might, perhaps, be a new discovery. But whether the thought presented was new or old, his lectures and public addresses were, with few exceptions, extemporaneous, or, at all events, largely dependent upon the inspiration of the moment for their form of words. He was a fluent speaker using English, though evidently not a vernacular tongue, with ease and accuracy, hesitating or rather pausing, sometimes for a moment, not as if there was any deficiency of thought or words, but as if he was in doubt which to select from a throng of ideas presenting themselves. The secret of his great personal influence, which enabled him to secure from wealth the assistance that his extensive scientific undertakings required, lay principally in his singleness of soul. He had but one object ever in view, and other matters were not merely subsidiary—they were all but forgotten. A publishing firm wrote to him urging him to write a book on natural history for use in schools, and offering him a large pecuniary inducement. "I wrote them," said he, and his eyes sparkled with indignation, "that I was not the man to do this sort of work; and I told them, too, that the less of this work was done the better. It is not school books that we want, it is students. The book of nature is always open. All that I can write and say shall

be to make them study that book, and not pin their faith to any other." The self-denial of Professor Agassiz may be better appreciated when it is mentioned that the salary of his professorship was only $1,500 a year. His love for truth in science was only equalled by his antipathy to shams and falsehood. In the rare instances where he thought imposition was practised, it called forth from him a fierce wrath that astonished those who had only seen the gentler side of his nature. Some friends made an arrangement, when a noted exhibition of "spiritualists" was in progress, to have a scientific investigation of the alleged "phenomena," and invited Professor Agassiz to make one of the party. He turned his back upon his friends, pointing them to the open door in almost speechless anger, and only adverted to it afterward in expressions of surprise that anybody who knew him should insult him by asking him thus to waste his time.

Of Agassiz, as a scientist, crowned with direct and visible achievements, it is a pleasure to speak. At an early age (says Dr. Talmage) he began to reduce the fossil remains of fishes into intelligible and orderly classifications. In five volumes, accompanied with hundreds of plates, folio in size, he built up what had hitherto been a chaotic mass of materials into a beautiful and connected system truly deserving the name of science. He was the originator of the theory in regard to the existence and movements of glaciers, which though long and violently opposed, is now generally accepted as affording the best explanation of the mighty catastrophes that evidently took place in the remote periods of our planet's history. An index of names and classification for the entire animal kingdom, a standard book which students are continually consulting, was another result of comprehensive and tireless genius. Nor will those intensely interesting and eloquent lectures, which he delivered without notes, upon comparative zoology and kindred topics, be entirely lost to the future. Fortunately for us, as well as for himself, he had a profoundly appreciative and accomplished wife, who made it her loving task to catch and preserve in writing, as often as opportunity allowed, his public utterances. And if these came from the press as popular in style, on account of their familiarity of illustration and pure Saxon wording, as they were when pronounced under the inspiration of the platform, they will add much to the general estimation in which her beloved husband is already held. But Agassiz's great object, as declared by himself before the Massachusetts Legislature, was to have "a museum founded here which shall equal the great museums of the old world." And what pains he took to realize this was evinced by his expeditions in search of curiosities to Lake Superior, to the Florida Reefs, to the Amazon region, around Cape Horn, and elsewhere. And how successful he was in reaching his object—nay, in surpassing his own expectations—is equally attested in the testimony of Professor Tyndall, that in the immense collections thus gathered are

several departments superior to anything in Europe. Upon his novel and most hopeful experiment on Penikese Island, where, by abjuring text-books, and by compelling his pupils to take lessons directly from nature, he intended to show that the purely inductive method was the only one to make discoverers, and upon his resistance to the doctrine of evolution, and upon his vast projects, our space forbids us to enlarge.

A few days only before his death, Prof, Agassiz completed a paper "On Evolution and Permanence of Type." This has been printed in the *American Monthly*, and is well deserving attention, the author's views with regard to the evolution hypothesis being well known.

Professor Agassiz lost one of his most valuable assistants in the death of Dr. G. A. Maack, in the thirty-third year of his age. He was connected with the Cambridge Museum for several years, during which time he was detailed by his chief to act as geologist of the Darien Isthmus exploring party, under Commander Selfridge, and also prosecuted similar researches in Brazil and elsewhere in South America. He was specially charged with the osteological collection of the Cambridge Museum, which he managed with great ability.

Baron von Liebig, the great chemist, was born at Darmstadt, the capital of the Grand Duchy of Hesse-Darmstadt, in 1803. After having completed his classical education at the Gymnasium of his native city, his father, who all along had noticed his excessive partiality for chemistry and for other branches of natural science, was induced to place him, when about fifteen years of age, in a pharmaceutical establishment at Heppenheim. Here Justus Liebig, in 1819, entered as a student at the University of Bonn, whence he was transferred to Erlangen, where he took the degree of Doctor of Medicine before he was of age. In 1823 he communicated to the French Academy of Sciences a memoir on Fulminic Acid and the Fulminates. Liebig "was the first who explained their true chemical constitution;" and his memoir on the subject excited so much interest, not only in Paris but in other countries, that Humboldt invited the author to his house, and gave him such strong letters of recommendation to the authorities of the University of Giessen that, although the subject of this memoir was only just twenty-one years of age, he was appointed Professor Extraordinary of Chemistry, a position which, some two years later, he exchanged for the higher and more permanent post of Ordinary Professor. He now, under the patronage of the Government, commenced that model laboratory for teaching practical chemistry which attracted students from every part of Europe, not to speak of other quarters of the globe, and enabled him to send out into the scientific world such distinguished chemists as Hoffman, Wiess, Fresenius, Gregory, Johnston, and Dr. Lyon Playfair, who were proud to reckon themselves in the number of his pupils.

In 1837 Liebig attended the meeting of the British Asso-

ciation for the Advancement of Science, at Liverpool, when he read a valuable paper "On the Composition and Chemical Relations of Uric Acid;" which was held in such estimation by the chemical section of the Association that he was requested to draw up two Reports—the one on Isomeric Bodies, and the other on Organic Chemistry. Before the meeting which was held at Glasgow, in 1840, Liebig had published at Brunswick his work entitled *Organic Chemistry in its Application to Agriculture and Physiology*, which was translated into English from the author's manuscript, and dedicated to the British Association. "This work," observes Sir D. Brewster, "was only a part of the Report on Organic Chemistry which that body had requested at his hands;" but an abstract of the whole Report was read on his behalf by Dr. Lyon Playfair before the Chemical Section at Manchester in 1841, under the title of "Organic Chemistry applied to Physiology and Pathology." The entire Report was published in 1849, under the title of *Animal Chemistry, or Chemistry in its Application to Physiology and Pathology*. It was translated into English from the author's manuscript by Dr. Gregory; a French version of it also was published at Paris.

In 1848 Professor Gregory translated from the manuscript and published Liebig's work on *The Motions of the Juices in the Animal Body*, and in the following year his *Researches on the Chemistry of Food*. Liebig had already published his most popular work, and that by which, after all, his name will be most widely remembered, his *Familiar Letters on Chemistry considered in its Relation to Industry, Agriculture, and Physiology*. A second series of these *Familiar Letters* appeared in 1844, or the following year, and they have since passed through several editions. Liebig must be honoured with the credit of having very extensively simplified the processes for organic analysis. He was also the sole author of nearly three hundred, and the joint author of from thirty to forty, separate memoirs on chemical subjects. He co-operated with M. Poggendorf in the *Dictionary of Chemistry* published by him in six volumes at Brunswick in the years 1837-1856, and in a "Supplement" to the same work in 1851-52.

The scientific attainments and valuable researches of Liebig were rewarded with honours of various kinds in almost every country where natural science is held in honour. In 1845 the Grand Duke of Hesse-Darmstadt, Louis II., conferred upon him an hereditary barony, and thenceforth he was known as the Baron von Liebig. In 1840 he had been chosen a foreign member of our Royal Society, and had received its Copley Medal for his researches in organic chemistry. He accepted a Professorial chair, and afterwards the post of President of the Chemical Laboratory, in the University of Munich, the duties of which he discharged most ably and efficiently until the commencement of the illness under which, after a partial recovery, he has ultimately sunk.

In 1854 a fund of about a thousand pounds was raised by subscription throughout Europe for the purpose of marking the value set by the public on his chemical and agricultural researches, and it was expended, as we are told by Sir David Brewster, in the purchase of five pieces of plate—one for each of his children—as memorials of the parent who is now no more. In a practical country like England his name will doubtless be remembered less for his purely scientific attainments than for the advance in practical agriculture which has followed from his researches into the laws of chemistry. He was a frequent visitor to England during the last thirty years or so, and his presence was always gladly hailed at our leading agricultural and scientific meetings. In the recent discussion upon the vexed question of the utilization of sewage he took an active and constant interest; and his views, to say the least, have tended considerably to increase and extend the knowledge previously existing on this most important subject. In English households his memory will, however, be, perhaps, still better remembered as the inventor of the preparation of meat extract which bears his name.—Abridged from the *Times*.

Sir Henry Holland, whose name has been familiar to the world during the greater part of the present century, cannot be regarded as a man eminent in scientific research. Still, as a Fellow of the Royal Society of nearly sixty years' standing, as President of the Royal Institution, as one who was ever ready to contribute towards the advancement of scientific research, and as the friend of all the most eminent men of science of his time, which was a long one, we deem him worthy of a passing notice. As much as for anything else, Sir Henry was known as an indefatigable traveller; his fondness for travelling, indeed, having led to the illness which was the immediate cause of his death, within two days, on October 27 last, his eighty-sixth birthday. He began his travelling career by a visit to Iceland in 1810, since which he has explored almost every corner of Europe, and been eight times in America. In his *Recollections of Past Life*, published in 1872, he speaks thus of his travels:—

"The Danube I have followed, with scarcely an interruption, from its assumed sources at Donau-Eschingen to the Black Sea—the Rhine, now become so familiar to common travel, from the infant stream in the Alps to the 'bifidos tractus et juncta paludibus ora,' which Claudius with singular local accuracy describes as the end of Stilicho's river journey. The St. Lawrence I have pursued uninterruptedly for nearly 2,000 miles of its lake and river course. The waters of the Upper Mississippi I have recently navigated for some hundred miles below the Falls of St. Anthony. The Ohio, Susquehanna, Potomac, and Connecticut rivers, I have followed far towards their sources; and the Ottawa, grand in its scenery of waterfalls, lakes, forests, and mountain gorges, for 300 miles above Montreal. There has

been pleasure to me, also, in touching upon some single point of a river, and watching the flow of waters which come from unknown springs or find their issue in some remote ocean or sea. I have felt this on the Nile at its time of highest inundation, in crossing the Volga when scarcely wider than the Thames at Oxford, and still more when near the sources of the streams that feed the Euphrates, south of Trebizond."

It was mainly on account of the reputation which even then he had achieved as a traveller, that he was elected a Fellow of the Royal Society in 1815. Sir Henry was elected President of the Royal Institution in 1865, and took the very warmest interest in its success, and in the promotion of scientific research, being seldom or never absent from his post, doing much to popularise science among the upper classes, with whom, as our readers know, he was always a welcome guest.

Of Sir Henry's contributions to literature, his *Medical Notes and Reflections* (1839) and his *Chapters on Mental Physiology* (1852) are well known to the medical profession. He contributed a considerable number of articles to the *Edinburgh* and other reviews, which, in 1862, were published as *Scientific Essays.* In 1815 he published his celebrated *Travels in the Ionian Isles and Greece.* In 1816 he contributed to the *Philosophical Transactions* a memoir on the manufacture of sulphate of magnesia at Monte della Guardia, near Genoa, and afterwards papers to various other scientific journals. Last year he published his well-known *Recollections of Past Life.*

Sir Henry Holland was born at Knutsford, Cheshire, October 27, 1787, and was educated at Newcastle-on-Tyne, and at the school of Dr. Estlin, near Bristol, where he became head boy. In 1804 and 1805 he attended Glasgow University, and in 1806 he entered the Medical School at Edinburgh, where he became acquainted with many of the notable men that then frequented "the grey metropolis of the north"—Sir Walter Scott, Brougham, Sydney Smith, Horner, Jeffery, Dugald Stewart, and Sir William Hamilton. In 1816, after spending some time in travel, he established himself in London, and at once achieved high professional success. He became Physician in ordinary to the late Prince Consort in 1840, and to the Queen in 1852; and next year was created baronet. Sir Henry was twice married; his second wife, who died in 1866, was the daughter of his old friend, Sydney Smith.—Abridged from *Nature.*

ALBANY HANCOCK. His early taste for natural history pursuits was probably in part derived from the collections, chiefly conchological, formed by his father; and associations with Mr. Robertson and Mr. Wingate, the one a botanist, the other an ornithologist, of repute; with the well-known Mr. Bewick; and above all with his near neighbour Mr. Alder, confirmed his inclination in this direction. He was, as a boy, clever with his fingers, and that manual dexterity which in later years served

him so well when engaged with dissecting needle and pencil, exhibited itself in many of the pursuits of his early life. The first mention we find of Mr. Hancock's devotion to natural history is in Mr. Alder's "Catalogue of Land and Fresh-water Shells," published in 1830. Early association with Mr. Alder in the study of the mollusca led to the production between the years 1845 and 1855 of their magnificent "Monograph of the British Nudibranchiate Mollusca," which may still be taken as a standard of excellence amongst such publications. Many of Mr. Hancock's earlier papers were devoted to the elucidation of the boring apparatus of the Mollusca, and these were followed by similar researches respecting the excavating power of a group of sponges (*Cliona* and allied genera) which until that time had been but little known or understood. He was, perhaps, the best known by his elaborate memoir on the Organisation of the Brachiopoda, published in the *Philosophical Transactions* for 1857. Amongst other papers will be remembered:—"On the Olfactory Apparatus in the Bullidæ" (1852); "On the Nervous Systems of *Ommastrephes todarus*" (1852); "On the Anatomy and Physiology of the Dibranchiate Cephalopoda" (1861); "On the Structure and Homologies of the Renal Organ in the Nudibranchiate Mollusca" (1863); "On the Anatomy of Doridopsis" (1865); "On the Anatomy and Physiology of the Tunicata" (1867). For some years previous to his death Mr. Hancock had devoted much attention to the fish of the Carboniferous period.—Abridged from *Nature*.

Sir Francis Ronalds, F.R.S., formerly Director at the Observatory at Kew. The son of the late Mr. Francis Ronalds, of Highbury, Middlesex; he was born in the year 1788, and received his early education at the Academy at Cheshunt. Although, with characteristic modesty, he constantly disclaimed the honour often ascribed to him of having been the "inventor" of the electric telegraph, yet it remains on record that nearly sixty years ago he devised a perfectly efficient instrument of that kind, which he fully described in a pamphlet published in 1823. His first success in this direction is described as follows in the *Philosophical Magazine*:—"In the summer of 1816 he undertook to prove the practicability of telegraphic communication, at great distances, by transmitting a certain number of electric shocks, for an arranged signal, through insulated wires of considerable length. He laid his wire in glass tubes surrounded by wooden troughs lined with pitch, which were placed in a covered ditch, 525 ft. long and 4 ft. deep, dug in his garden at Hammersmith. He also suspended eight miles of wire, by silk cords, from two wooden frames erected on his lawn, so that the wire passed to and fro many hundred times, well insulated at each point of attachment, and forming one continuous line, kept separate from contact with other parts. Both these kinds of apparatus served equally to show the instantaneous transmission of the electric shock.

In order to provide the means of conveying intelligence along the underground line, he placed at each end of it a clock, with a dial bearing twenty letters inscribed. In front of the dial was a disk, revolving with the seconds hand, forming a screen with a small opening cut in it, so that as the disk revolved only one letter could be seen at a time, and this only for a second. The two clocks were made to go isochronously, the one always presenting the same letter as the other at any given second of time; and the moment chosen at one end was indicated at the other by the sudden collapse of a pair of pith ball electrometers, suspended at each station close to the clock-dial and connected with the telegraph wire." By this contrivance, says a writer in the *Illustrated London News*, "letter after letter could be denoted, and words spelt out as certainly as by the telegraphic apparatus of Messrs. Wheatstone and Cooke, invented at a later period and patented in 1837." The same writer adds a fact which, read by the light of science at the present day, will cause a smile—namely, that when Mr. Ronalds proposed that a telegraph of his construction should be laid down between London and the residence of the Prince Regent at Brighton, and with that view submitted his project to Lord Melville, then at the head of the Admiralty, he received a curt official reply from "their lordships" of that Department, intimating that "telegraphs of any kind are now wholly unnecessary, and that none other than that now in use will be adopted." The word "now," of course, referred to the recent end of the long European war and the fall of Napoleon. Sir Francis Ronalds was the original Honorary Director of the Royal Observatory at Kew, a (post which he held from 1843 to 1852), and the inventor of various self-registering instruments which are employed there, as well as at the Royal Observatory at Greenwich, at the Radcliffe Observatory at Oxford, and in several foreign observatories, all of which were fully described by him at various times in memoirs and papers read before or published by the Royal Society, the British Association, &c., and also in a French pamphlet which accompanied their display at Paris in the Exhibition of 1855. In 1870 he received a somewhat tardy reward for his public services in the cause of science by being knighted, "in acknowledgment of his early and remarkable labours in telegraphic investigation." A scientific account of these will be found in his pamphlet published fifty years ago. He had already been for some years—we believe since 1852—in receipt of a pension on the Civil List.—*Times*.

THE INSTITUTION OF CIVIL ENGINEERS.—In the quarter ended on the 31st of December, 1872, the deaths of Mr. Joseph Cubitt, Vice-President, of Mr. Andrew Murray, C.B., both of whom belonged to the class of members; and of Messrs. Edwin Bidder, Hamilton Edward Harwood, J. Archibald Hamilton Holmes, John Jay, and Arthur Valentine, associates, were recorded.

LOUIS LE CHATELIER, Inspecteur-Général des Mines. M. Le Chatelier, who was born in 1815, was the most brilliant of the pupils of the École Polytechnique of 1834 to 1836, and entered the Corps of Mining Engineers of the State. Here his scientific services were of so high a character that in 1846 he was chosen by the Government to control the railways then in activity. In 1848 he became engineer-in-chief of the working management of the companies of the Centre and of the Paris and Orleans Railway. During this period of his career Le Chatelier investigated many questions of the principles of the construction of locomotives and rolling stock, and established his great reputation as an engineer and a man of science. In rapid succession were published "Recherches Experimentales," "Experimental Researches on the Locomotive," in collaboration with M. Ernest Gouin, his work on the "Railways of Germany," his studies on the "Stability of Locomotives," and the "Guide Mécanicion Constructeur," which latter he edited in conjunction with Flachat and Polonceau.

In 1855 he was of the committee of the Southern of France Railway, with MM. Clapeyron and Flachat, and of that of the Austrian Railways, with M. Maniél. Later he was associated with M. Sauvage in the Great Russian Railway Company, of the council and direction of the Great Northern of Spain, and administrator of the Transatlantic Company.

During all this time he served the State on many important commissions for railways, steam-engines, arts and manufactures, and universal exhibitions. He gave in a complete project for the supply of Paris with drinking water, and then for the purification of the sewer waters.

With his friend, M. Henri Sainte Clair Deville, he developed the manufacture and application of the new metal aluminium, made investigations on the aluminates and fluosilicates, and introduced the use of bauxite for the sides and hearths of furnaces. He was the first to perceive the immense value of Siemens's regenerator gas furnaces for making steel direct from pig iron. In agriculture, he called attention to the use of saline manures, phosphates, and coal-ashes, and expended much time in setting the example of their use in the cultivation of the Landes.

Lastly, he made over to the railway world his invention of the counterpressure steam brake, for which the authorities of the Vienna Exhibition bestowed on him the Diploma of Honour in the Mechanical Section.

Such a career of untiring good work is an example to all. France loses in M. Le Chatelier the last of a brilliant pleiades of engineers taken away since 1870—MM. Petiet, Maniél, Sauvage, Flachat, Audibert, who, with MM. Clapeyron and Polonceau, organised the railways of France and directed the most important works of our epoch.—*Engineer*, abridged.

EUGENE FLACHAT, who after having several times occupied

the presidential chair of the Société des Ingénieurs Civils, was elected an honorary president of that Society. But it was to the introduction of railways into France, and the subsequent development of the French railway system—a work on which he was engaged since the year 1832—that he devoted his chief energy. After having directed for several years the railways of Saint Germain and Versailles, he constructed that of Auteuil, and contributed to the establishment of the Southern and Western Railways of France, while he also rendered special services in connection with the carrying out of the Northern Railway of Spain, a line of which he was engineer-in-chief at the time of his death. It is to M. Flachat that is due the first application in France of the electric telegraph, which he employed on the railway of St. Germain, a line on which also he introduced the use of the first locomotives for heavy inclines. To him, too, were due the first large iron roofs, the first continuous girder bridges—and, as a fact, the first iron bridges in which the parts were correctly proportioned to the strains thrown upon them—erected in France, if not, indeed, in any country.

M. Flachat's most important works, apart from railways, consisted in the part taken by him in the construction of the Halles Centrales of Paris, and in the reconstruction of the cathedral of Bayeux, an edifice of which he rebuilt the foundations without interfering with the structure.

J. MACQUORN RANKINE, pupil of the celebrated Professor Forbes, wrote a paper entitled "An Experimental Inquiry into the Advantages of the Use of Cylindrical Wheels," published in 1842. Mr. Rankine at first served under Sir John Macneil, in Ireland.

"It is well known," he says "that locomotive engines moving at a high speed are liable to be thrown off the rails by trifling obstacles; and, indeed, that they sometimes leap off spontaneously, without having met with any obstacle that can be detected. This evidently arises from the circumstance that a carriage, and especially a locomotive engine, with conical wheels, never moves straight forward but for an instant at a time; so that whenever a small obstruction, or an increase of speed beyond a certain limit, causes it to leap higher than the depth of the flanges, it is almost certain to alight off the track. This source of danger, which has been the cause of many accidents, is entirely removed by the use of cylindrical wheels."

"I am fortunately able," he proceeds, "to produce a remarkable proof of this fact, in an accident described in a paper which I some time since laid before the Institution of Civil Engineers. Thirteen empty waggons ran amain from the summit on an inclined plain 1,160 yards long, sloping at the rate of 1 in 30; and notwithstanding the weight of some of their brakes, acquired a high velocity, which it was impossible to estimate exactly. They met with no obstruction until they reached the bottom of the plane, where a 3-in. plank was laid across the

rails for the purpose of throwing them off; they all leapt over the plank in succession, alighted, without a single exception, on the rails beyond it, and continued their course at a velocity of about twenty miles an hour.

"This is attributable solely to the use of cylindrical wheels; and, remarkable as it may appear, is only one out of innumerable instances in which carriages have leapt over stones and other obstacles without being thrown off the rails."

Soon after he entered upon the duties of the Regius Chair of Civil Engineering and Mechanics in the University of Glasgow, Professor Rankine turned his attention to the production of a series of Manuals for engineering students and practical men, which, taken together, constitute a monument of patient, persevering, and skilful original investigation, of vast scientific grasp of mind, and of brilliant literary workmanship—a monument which cannot fail to carry down to posterity the memory of the man whose honourable name is borne upon their title-pages. These Manuals are so thoroughly well known and appreciated by the profession that it is not incumbent that we should in any way enlarge upon them here.

THOMAS GREENWOOD, Civil Engineer, whose name has long and well been associated with the progressive development of the more complex classes of labour-saving machinery. Long before machinery for interchangeable manufacture was known in England, Mr. Greenwood designed machinery embodying all the principles, and containing nearly all the motions, of the now familiar milling machine, which in its varied forms has come to be employed in all establishments where the interchangeable system of manufacture is carried on.

Mr. Greenwood was appointed chief draughtsman at Mr. Fairbairn's works at the Wellington Foundry. Mr. Greenwood's experience in plate or stereotype moulding enabled him to arrange a successful system of shell moulding upon that principle at Woolwich, the saving to the country effected in the new shell foundry being very great. Taking the prices which had been paid by the Government for shot and shell, especially in time of war, when work was done under pressure, it was found that the saving effected during one year's working of the new foundry alone covered the whole cost of buildings, plant, and machinery. Besides the shell-founding apparatus, Mr. Greenwood designed machines for the manufacture of Boxer fuses; bushes for shells; rocket-making and filling machinery; and for various other purposes.

M. DE METZ, the founder of Mettray.

JOHN ROBINSON M'CLEAN, M.P. Mr. M'Clean, who was a son of the late Francis M'Clean, of Belfast, was born in 1813, and was educated at a school at Tillicoultrie, N.B., afterwards at the Belfast Institution, and at the University of Glasgow. Mr. M'Clean was one of the senior members of the Institution

of Civil Engineers, of which Institution he had held the office of President; while he was a Fellow of the Astronomical, the Geological, and other scientific societies, and had presided as a director and chairman or deputy chairman over one or two telegraph companies, and also many other important companies connected with his profession.

JEAN CHACORNAC. — This eminent French astronomer is described as chiefly known for his discoveries among the planetoids whose orbits are contained between those of Mars and Jupiter. In his earlier years he devoted himself to commerce; but having, in 1851, made the acquaintance of M. Valz, Director of the Marseilles Observatory, Chacornac became an enthusiastic student of astronomy, devoting himself to research in connection with the solar spots, and to the assiduous exploration of the heavens. On his discovery of a new comet on May 15, 1852, he made up his mind to abandon commerce and devote himself entirely to astronomy.

In 1852 M. Valz, following the example of Mr. Hind, had drawn some charts of the region of the heavens in which the small planets were likely to be met with, and on Chacornac taking the above decision, Valz entrusted to him the construction of the "Atlas écliptique." Chacornac commenced his observations on the region of the small planets on June 1, 1852, and on September 20 he discovered Massalia, and on April 6, 1853, Phocæa, and that with an equatorial telescope of only thirteen centimetres aperture.

When M. Le Verrier sought to reform the *personnel* of the Paris Observatory, he called to his aid M. Chacornac, who, in 1854, was appointed Adjoint Astronomer.

At the Observatory of Paris Chacornac had at his disposal an equatorial of 7-in. aperture, equal to that of Mr. Hind; he set down in his charts stars up to the 13th magnitude, and the limits which they embraced were at the same time somewhat extended. The publication commenced very soon after, and from 1854 to 1863 thirty-six charts, of which some contained not less than 3,000 stars, were put into the hands of astronomers.

During the construction of these charts, Chacornac discovered many small planets—Amphitrite (March 3, 1854), Polymnia (October 28, 1854), Circe (April 6, 1855), Lydia (January 12, 1856), Lætitia (February 8, 1856), and Olympia (September 12, 1860). At the same time he observed all the comets which were then visible, and defined, with the telescope of Foucault, of 80 centimetres, many spiral nebulæ, previously studied by Herschel. The drawings of M. Chacornac are among the most careful we possess, and appear to show that nebulæ of this kind undergo in time slight variations of form.

This collection of remarkable works brought to the astronomer of the Paris Observatory many academic and honorary rewards: thus, he obtained the Lalande Prize in 1852, 53, 54, 55,

56, 60, and 1863, became titular astronomer February 26, 1857, and Chevalier of the Legion of Honour August 15, 1857.

His labours, however, and their attendant anxieties, told upon his health. After going to Spain, where he went to observe the total eclipse of the sun of July 18, 1860, the ecliptic charts were issued less frequently, and in June, 1863, he quitted the Observatory to retire to Ville Urbanne, in the suburbs of Lyon.

In his country retirement M. Chacornac, whose spirit had preserved all its activity, constructed with his own hands a telescope of three metres focus, by means of which, until within the last few months, he assiduously observed the solar spots and their manifold transformations. In the description of their incessant changes he sought new proofs of the gaseous nature of the sun—an idea which he was one of the first to announce.

Professor Donati, Director of the new Observatory at Florence. His name is universally known, from its being connected with the splendid comet of 1858, which he was the first to discover on the 2nd of June of that year. But this was by no means his only cometary discovery. His first was made in 1854, though on that occasion he had been anticipated. But the priority remained with him in a like discovery on June 3, 1855, November 10, 1857, and July 23 and September 9, 1864, as well as on June 2, 1858, before referred to. Of these and other comets Professor Donati made many observations, besides determining the orbits of several. He also made many interesting spectroscopical examinations both of comets and of the solar disc, besides other astronomical investigations.

M. Coste, the well-known naturalist and member of the French Institute. He first devoted himself chiefly to the study of comparative embryogeny, and his earlier works attracted so much attention that a special professorship was created for him at the College of France. Of late years he had chiefly applied himself to the science of the artificial production of fish, and it was on his recommendation that the Government in 1851 founded the breeding ponds at Huningen, for stocking the Rhône with salmon and trout, and which in two years produced 600,000 young fry in that river. As inspector-general of fluvial and coast fisheries, he also made numerous experiments for the propagation of oysters, but the expectations which had been raised by his theories have not so far been realised by the results obtained. M. Coste was the author of numerous physiological works and reports to the Academy of Sciences.—*Nature.*

Professor Czermak, the eminent physiologist.

Professor Barker, M.D., Professor of Experimental Physics in the Royal College of Science for Ireland.

Thomas Wormald, F.R.C.S., at Gomersall, Yorkshire. He commenced his professional studies under the celebrated John

Abernethy, to whom he was apprenticed at the Royal College of Surgeons. Having completed his hospital studies, he was admitted a member of the College of Surgeons on March 5, 1824. He had previously assisted as Demonstrator of Anatomy at his hospital, and, in conjunction with the late Mr. M'Whinnie, published some anatomical diagrams of great use to students. In the Royal College of Surgeons he filled all the highest offices, having been elected in the first batch of Honorary Fellows of that institution on December 11, 1843; and in 1849 he was elected, in conjunction with the latet Messrs. Hodgson, Pilcher, and Bishop, a member of the Council. In 1857 he was appointed Hunterian Orator, when he delivered an admirable oration before a large audience. In 1865 he received the highest honour his colleagues could confer on him—the President's gown.

Sir John Bowring, F.R.S., had reached the age of eighty. When merely a boy, John Bowring was sent to Spain as clerk to an Exeter mercantile firm which had an agency in that country, shortly after the close of the Peninsular War. He was soon afterwards employed by our Foreign Office to collect statistical information on the Continent for the advantage of British trade. At the same time he displayed his versatile talent in literary pursuits. (Translations chiefly of poetry) from different modern languages—Spanish, Russian, Polish, and others—gained him a popular reputation for scholarship. He acted meanwhile as literary secretary to Jeremy Bentham, whose literary executor he became on Bentham's decease, and published a complete edition of that philosopher's works. In 1825 he became editor of the *Westminster Review*, which was the organ of critical and philosophical Radicalism. His pamphlets and essays, however, on questions of commercial policy were the most serviceable productions of Dr. Bowring (LL.D. of Groningen). When he had a seat in the House of Commons, he carried, in opposition to the Government, a resolution that the gross revenues of all taxes should be paid without reduction into the Exchequer. Aided by the support of Prince Albert, he obtained, after a discussion in the House of Commons, the issue of the florin, which was the first step towards the introduction of the decimal divisions into our currency. In 1849 he was appointed British Consul at Canton; in 1854, while on leave of absence in England, he was promoted to be her Majesty's Plenipotentiary in China (having previously held temporarily the post of Chief Superintendent of Trade) and Governor of Hong Kong, and received the honour of knighthood. In the spring of 1855 Sir John Bowring went on a special mission to Siam, and concluded a treaty of commerce with the two kings of that country—a task in which several previous negotiators had failed. He afterwards published his travels under the title of *The Kingdom and People of Siam.* Having retired on a pension in 1859, he subsequently published

an account of the *Philippine Islands.*—Abridged from the *Illustrated London News.*

BARON WESTBURY, the distinguished lawyer and statesman, Lord High Chancellor of England. The Rev. J. C. J. H. Abrahall, of the Rectory, Butterleigh, Collumpton, and Lord Westbury were schoolfellows in 1809–11, at the Fort, Bristol, under the Rev. R. Bedford. The school was broken up, when young Bethell came under his father's instruction until, at the very early age of fifteen, he was elected Scholar of Wadham. Mr. Abrahall speaks from certain knowledge, having been himself a scholar of the same College and Foundation.

JAMES HOLMES, for many years the printer and part proprietor of the *Athenæum*. Mr. Holmes was born at Exeter, and received his education at the Grammar School of that city. He served his time as an apprentice to the late Mr. Robert Besley, the father of Mr. Alderman Besley. When his apprenticeship was at an end he came to London, and worked at the printing-house of Mr. Valpy, the well-known publisher of editions of the Classics. He afterwards went to Messrs. Bensleys', where he was employed as a proof-reader down to the close of the year 1824. He became the printer of the *Law Journal* and *Law Advertiser*. During 1827-8 he printed the *London Weekly Review*, which was discontinued early in 1829. The *Court Journal* was also originated at Mr. Holmes's office in 1829. In the same year Mr. Silk Buckingham sold the *Athenæum* to Mr. John Stirling, and shortly afterwards the printing of the journal was transferred to Took's Court. Mr. Holmes then became one of the proprietors of the paper. In the year 1869 Mr. Holmes sold his share in the *Athenæum*, and retired from business. He died in the eighty-fourth year of his age. As a printer, Mr. Holmes possessed great taste. He was an unusually good press-reader, and was well acquainted with the classics and with modern languages.

JOHN STUART MILL, the eminent Political Economist, and author of a *System of Logic*.

DAVID LIVINGSTONE, the African Explorer. The following testimony to Livingstone's character is from the pen of Mr. E. D. Young, R.N. :—

"His extensive travels place him at the head of modern explorers, for no one has dared as yet to penetrate where he has been; no one, through a lengthy series of years, has devoted so much of his life to the work of searching out tribes hitherto unknown; and I believe that his equal will rarely, if ever, be found in one particular and essential characteristic of the genuine explorer. He has the most singular faculty of ingratiating himself with natives whithersoever he travels. A frank openhearted generosity, combined with a constant jocular way in treating with them, carries him through all. True, it is no-

thing but the most iron bravery which enables a man thus to move among difficulties and dangers with a smile on his face instead of a haggard, careworn, and even a suspicious look. Certain it is, also, that, wherever he has passed, the natives are only too anxious to see other Englishmen, and in this way we must crown him 'the King of African Pioneers.'"

Livingstone had his faults and his failings; but the self-will and obstinacy he possibly at times displayed were very near akin to the qualities which secured his triumphant success, and much allowance must be made for a man for whom his early education had done so little, and who was forced, by circumstances around him, to act with a decision which must have sometimes offended his fellow-workers. Above all, his success depended, from first to last, in an eminent degree upon the great power which he possessed of entering into the feelings, wishes, and desires of the African tribes, and engaging their hearty sympathy.

Francis Garnier, a lieutenant de vaisseau, and the second in command of the exploring expedition which in 1866, 1867 and 1868, ascended the Mekong river from Saigon, and succeeded in making its way down the Yang-tze-Kiang to Shanghai; indeed, it was he who assumed the leadership of the party when Captain Lagrée perished on the frontiers of Yunnan. On his return to Europe, M. Garnier spent some four years in superintending the official account of the journey in which he had taken so prominent a part, and the result of his labours is to be found in the three bulky volumes which were published by the French Government in 1873.—*Athenæum.*

John MacCunn, a well-known and much-respected ship-owner and merchant, at seventy-one years of age. The deceased gentleman was well-known in shipping and commercial circles, not only in Greenock and the West of Scotland generally, but also in London, Liverpool, &c. Some of the ships owned by him while in the China tea trade have earned a world-wide reputation for having made some of the fastest passages on record.

Captain Maury, the American hydrographer and astronomer.

George Catlin, the intrepid traveller in North America.

Chapelont Labat, some time Minister of Marine.

Dr. Fuerst, the Orientalist.

Sir Robert Maclure.

Samuel, Lord Bishop of Winchester. "He was," says the Rev. Henry White, Chaplain of the House of Commons, in his sermon preached at the Royal Chapel, Savoy, "above all things, earnest as a ruler of the Church and a preacher of the gospel—a preacher who was not content to deliver his Master's message in an enfeebled array of truisms and common-places, but who was ever conscious and capable of genuine,

fervent, and therefore eloquent, appeals to his hearers. Through all his teaching and ruling there ran a golden cord of kindliest and subtlest sympathy for others. It is no disrespect to his colleagues and contemporaries in Church or State to say that there are scarcely ten men in these realms who could by sheer force of religious earnestness, sympathy, catholicity, and tact triumph, as the Bishop did repeatedly, over powerful and prejudiced opposition. As a man, and as a prelate, we could never so ill afford to lose him as at present; but, though dead, 'he yet speaketh.'" At St. Paul's Cathedral, Dr. Claughton, Archdeacon of London, preached in the forenoon a sermon with reference to the death of the Bishop. He chose for his text the 4th verse of the 2nd chapter of St. Paul's Epistle to the Philippians. He remarked that the deceased had great power in guiding and influencing his fellow-men, and they all knew how well he exercised that power. His views were sound, Evangelical, and Scriptural, combined with a love for all that in ancient times had been held sacred in the Church. Learned in the ordinary sense he might not have been, but he was a student of mankind, leaning to activity rather than to philosophical speculations. His great end was the building up of the Church of Christ, and the brief notice on his coffin summarised the events of his life, "Twenty-eight years a Bishop in the Church of God." In the afternoon the sermon at St. Paul's was preached by Canon Gregory from the parable of the "Five Talents." He passed a high eulogium upon the character of the late Bishop, who had met with much opposition; but that would die away when it was known how he had raised comparatively small events into great opportunities.

THE REV. THOS. GARNIER, Dean of Winchester, who died at the age of ninety-eight, was the "father" of the Linnean Society, having been elected during the last century, in 1798, only ten years after the foundation of the Society. Some of his contributions to botanical literature bore the date of last century.

THE REV. W. UPTON RICHARDS, the well-known London clergyman and once leading member of the High Church party. He was educated at Oxford. He held for several years an appointment in one of the departments of the British Museum, and succeeded Mr. Oakeley in the incumbency of Margaret Street Chapel in 1849. He was an intimate friend of Messrs. Keble and Isaac Williams, and also of Dr. Pusey, who addressed to him, as *amicus curiæ*, one of his controversial pamphlets a little more than twenty years ago, on the subject of auricular confession, entitled, *The Church of England leaves her children free to open their griefs.*

M. DYMOKE, of Scrivelsby, Her Majesty's Champion.

M. A. THIERRY, historian.

LAFONT, French actor.

PRINCE PONIATOWSKI, the composer.

ROBERT GRAVES, A.R.A., engraver.

PROFESSOR BUCHANAN, of Glasgow.

THE COUNTESS GUICCIOLI, novelist.

LADY CHATTERTON, novelist.

J. A. WINSLOW, the American Admiral.

BENZONI and HIRAM POWERS, sculptors.

VON RAUMER, the Nestor of German historians.

M. TRICOUPI, historian and diplomatist.

BARON CHARLES DUPIN.

WILLIAM C. MACREADY, tragedian.

A. MANZONI, the poet of Italy.

LORD LYTTON, poet and novelist.

SIR FREDERICK MADDEN, K.H., of the British Museum.

GEORGE ORMEROD, of Sedbury Park, Gloucestershire, F.R.S., F.S.A., D.C.L., &c., a well-known antiquary; aged 87.

JOHN GOUGH NICHOLS, F.S.A., the third in a race of English printers whose names have for upwards of a century been closely identified with everything bearing on English topography, genealogy, &c.; and of which his grandfather, the author of *The Literary Anecdotes* and the historian of Leicestershire, was the first. Of these Mr. J. Gough Nichols was undoubtedly the most eminent. Besides editing the *Gentleman's Magazine* for many years, he edited the *Collectanea Topographica* and the *Topographer and Genealogist*; and in 1862 commenced the *Herald and Genealogist*, which is still in course of publication; and in all these did good service to the cause of historical truth by his unsparing exposure of all false claims to titles and pseudo-genealogies. In addition to numerous papers in the various antiquarian journals, he was the author of many separate works. He was one of the founders of the Camden Society, and of the hundred and odd volumes illustrative of our national history issued by that society, several were edited by him, while nearly all the others contain acknowledgmemts from their respective editors of their indebtedness to Mr. Nichols, whose exrensive knowledge was always most freely placed at the service of others. Mr. Nichols lived to be the eldest member of the Literary Fund Committee, with one exception, having been elected to it in 1836.

JOHN ANTHONY GALIGNANI, the elder of the two brothers who many years back, by their talent, energy, and perseverance, raised the newspaper which bears their name to a high point of prosperity. He founded near Paris the "Galignani Hospital,"

intended specially for indigent English subjects; and, in addition, conjointly with his brother, defrayed the whole expense of building, in the vicinity of their country residence, the present large hospital of Corbeil.

JOHN CAMDEN HOTTEN, the publisher, aged 40. Allibone's *Critical Dictionary of English Literature*, sub voce *Syntax*, affords some idea of his literary labours as contributor to the *Literary Gazette*, the *Parthenon*, the *London Review*, &c.; and there, too, will be found a list of some threescore volumes either written or edited by him, among which may be mentioned his clever biographical sketch of Thackeray, and the *Story of Charles Dickens's Life*—the latter, as he wrote me at the time, the result of "twenty days' hard work."—*The Academy*.

PROF. JOHN LEWIS RUSSELL, of Salem, one of the founders, and for many years president of the Essex County (Massachusetts) Natural History Society, which afterwards became part of the Essex Institute, an active worker in botany; Mr. George Gibbs, of New Haven, the distinguished American ethnologist and philologist, whose special work had been in the language and history of the North American Indians; Col. John W. Forster, president of the Chicago Academy of Science, a constant contributor of papers and memoirs on geological and archæological subjects, and joint author with Prof. Whitney of the Government Report on the Mineral Lands of Lake Superior, published in 1850; and Prof. Henry James Clark, of Amherst, one of the most thorough histologists and best microscopists in the country, and a large contributor to Prof. Agassiz's volumes on the Natural History of the United States. Of these losses to science, Prof. Clark was under fifty, and only Prof. Lewis over sixty.—*Nature*.

FRANCOIS HUGO, politician. In the funeral procession, the car and the mourners having reached the tomb at Père la Chaise, the father of the deceased, Victor Hugo, immediately following the car, M. Louis Blanc delivered the funeral oration. After alluding to the natural grief under which M. Victor Hugo was labouring, the orator reminded his hearers that the son had shared the father's exile. Having described the political views and career of M. Victor Hugo and his son, M. Louis Blanc concluded by declaring, at the express instance of the father, that both the deceased and his sorrowing parent held a belief in God and in the immortality of the soul. At the conclusion of the address there was a slight applause. Upon quitting the cemetery the chief mourner was hailed with loud cries of "Vive Victor Hugo," "Vive la République."

FRANCIS XAVIER WINTERHALTER, the favourite Court painter of Her Majesty and of the late Prince Consort, whose portraits by him are familiar to us all through the engravers' art. He was about seventy years of age. He passed through a course of

professional training as a student in the Academy of Arts at Munich, and afterwards completed his studies in the galleries of Italy. Early in life he attracted the attention of Louis Philippe, and of some of the Kings and Princes of the various States of Germany: this in its turn led to his employment as a portrait painter by Her Majesty, who commissioned him to paint portraits not only of herself and of the Prince Consort, but of Sir Robert Peel and the Duke of Wellington. He also painted several other members of the Royal Family and of our aristocracy. It will be remembered that two portraits of the Empress Eugénie by Winterhalter formed conspicuous objects in the gallery of the Great Exhibition of 1862.

SIR EDWIN LANDSEER, R.A., the most famous animal painter of his time.

RICHARD JAMES LANE, A.R.A., one of the two Associate Engravers of the "old class" on the Academic rôle; and his associateship was one of the oldest in date. He won his reputation as a lithographer before lithography had been comparatively superseded by other rival processes. He likewise executed some original lithographic portraits, and reproduced subject-pictures in the same medium. He also wrote on art; and some humorous rhymes of a satirical and personal application, now forgotten, have been attributed to him.

JOHN PARTRIDGE, who in his day was a portrait-painter of considerable ability and repute.

CHARLES LUCY, the painter.

EDWARD THOMAS HARRIS, inventor of the scaffold for getting at the dome of St. Paul's, and of the great picture of London, at the Colosseum in the Regent's Park. In 1838 Mr. Harris painted for Mr. Moon a large picture, for engraving, of the coronation of Queen Victoria. In 1853 Mr. Harris completed the restoration of Thornhill's paintings in the dome of St. Paul's Cathedral. He died at the age of eighy-three.

J. P. MOLIN, the famous Swedish sculptor, who produced, besides other fine works, the ever-memorable 'Wrestlers,' which was the chief artistic attraction of the International Exhibition.

Signor RINALDO RINALDI, an Italian sculptor, formerly in considerable repute, as a follower of Canova.

DROUIN, a young Parisian painter of note; who killed himself, accidentally, with an over-dose of chloroform.

ANTOINE CHINTREUL, the able French landscape-painter.

SUSAN DURRANT, the sculptress.

THORNTON HUNT, the popular journalist.

AUGUST POITEVIN, sculptor, a pupil of Rude and M. Maindron.

At Düsseldorf, Herr C. T. CONRAD, a painter of merit.

In Paris, the old sculptor, M. AMÉDÉE DURAND, who was born in 1789, and gained a medal in the Ecole des Beaux-Arts in 1810. In Italy he produced busts of Murat and his children; afterwards he sculptured a statue of Religion for the monument of the Duc d'Enghien, in the chapel at Vincennes, and two fine medals, commemorating the passage of the Simplon and the embarkation of Napoleon the First on board the Bellerophon.

M. CELESTIN NANTEUIL, painter and lithographer, of considerable note, and lately Conservateur du Musée de Dijon, and Director of the École des Beaux-Arts in that place.

SIGNOR ERNESTO RAYPER, a promising young painter, of Genoa.

SIR WILLIAM TITE, M.P., the able architect. He will be principally remembered by his design of our third Royal Exchange.

JOHN Y. AKERMANN, archæologist; sometime the able and courteous Secretray of the Society of Antiquaries of London.

GODARD, senior, the oldest of the French aeronauts.

CHARLES KNIGHT, author and publisher, who, by his literary industry and taste, devoted himself systematically to the establishment of "a cheap and wholesome literature for the people." He was the son of an alderman of Windsor, whom he assisted in his business as a bookseller, and from whom he imbibed literary taste, as well as from George Canning, who was then the "working editor" of the *Microcosm*, printed in old Mr. Knight's office at Windsor. Charles Knight, at the age of twelve, was sent to Dr. Nicholas's school at Ealing. He had already (says the *Times*) picked up a smattering of Latin and French from an *émigré* priest in a day school at Windsor, and had devoured *Robinson Crusoe*, the *Arabian Nights*, *Gulliver's Travels*, the *Tales of the Genii*, and the *Seven Champions of Christendom*, with all the avidity of childhood. At Ealing he seems to have been but a desultory student, and one who, in spite of the gift of a very quick and retentive memory, liked English lore far better than his Latin Syntax and Prosody. He loved the school, however, and there, as a boy, he first was introduced to the late Sir Henry Ellis, for many years the genial and courteous ex-Librarian of the British Museum, then a fellow of St. John's College, Oxford, and a frequent visitor at Dr. Nicholas's house.

Knight's first connection with bibliography and literature is thus recorded by himself, and the event is so characteristic of his tastes that we venture to give it in his own words:—

"In my dealings in second-hand literature a circumstance occurred which had some effect in leading me to one of the most pleasant labours of my future life. I had been sent to a house

at Old Windsor to make a list of books belonging to a clergyman who had received an appointment in India. When the price to be given had been settled at home, I again went to make the offer, with the money in my hand. The generous man was pleased with what he considered liberal terms, and said to me, 'Young gentleman, I will give you that imperfect copy of *Shakespeare* for yourself.' It was the first folio, and sadly defective in many places. I devised a plan for making the rare volume perfect. The fac-simile edition, then recently published, was procured. Among the oldest founts of type in our printing-office was one which exactly resembled that of the folio of 1623. We had abundant fly-leaves of seventeenth-century books, which matched the paper on which this edition was printed. I set myself the task of composing every page that was wholly wanting, or was torn and sullied; and when the book was handsomely bound I was to have the copy for myself. But one of the Eton private tutors, to whom my father showed the volume, offered a tempting price for it, and my treasure passed from me."

And yet all was not lost. The very process of "setting up" the types led him to understand the essential differences of the early text as compared with modern editions of *Shakespeare*; and many years afterwards this "imperfect copy" of our great Poet's works blossomed into the *Shakespeare* with which Charles Knight's name will for ever be associated, to say nothing of other less important works bearing on our early dramatists and poets.

Charles Knight next joined his father in establishing, in 1812, the *Windsor and Eton Express* newspaper, of which he became editor. During the last years of his Windsor life he became the printer and the publisher of the *Etonian*. This circumstance led to an intimate acquaintance with Winthrop M. Praed, Macaulay, Sidney Walker, John Moultrie, and Derwent and Henry Nelson Coleridge, who afterwards, while undergraduates at Cambridge, became the chief contributors to *Knight's Quarterly Magazine*; and this, in its turn, led to the establishment of Charles Knight as a publisher in London in or about the year 1823.

In 1827 he became connected with the newly-founded "Society for the Diffusion of Useful Knowledge," which suddenly started into being under the auspices of such men as Brougham, Tooke,* Grote, Lubbock, Russell, Lefevre, Hobhouse, and the rest of the leaders of free thought and liberal opinions. He now commenced the publication of the *British Almanac*, with which he assailed the old almanac of Francis Moore, and other almanacs of the Stationers' Company. These were followed by his *Companion to the Almanac*—an annual storehouse of "useful" information on subjects connected with educational statistics, and other branches of social and political economy—and of his

* The Charter of the Society was drawn by Mr. William Tooke.

well-known *Library of Entertaining Knowledge*. This "Library" was the first of its kind, and it gave, more or less, the idea which was afterwards realised more completely in the *Family Library*, started by John Murray; and in *Lardner's Cabinet Cyclopædia*, published by Messrs. Taylor and Walton in Gower-street. Mr. Knight followed up his "Library" by the *Penny Magazine* and the *Penny Cyclopædia*, in both of which he called in the aid of wood engraving.

For about twenty years' connection with the "Useful Knowledge Society," continued, until, indeed, its leaders and Council thought that the time was come when individual enterprise would be able to carry out to a successful issue the various plans which they had inaugurated. Accordingly, other important works were now commenced by Mr. Knight on his own account, and without the positive support of the Society's name. The *Penny Magazine* had acted as a pioneer, and prepared the road for these, of which, as Mr. Knight tells us, the *Pictorial Bible* was the most successful as a permanent work, and the "Pictorial" edition of the *Arabian Nights* the most beautiful in artistic execution. These were followed by the *Pictorial Shakespeare*, which he styles "the most congenial undertaking of his literary life;" and the *Pictorial History of England*, certainly the most valuable of all as a contribution to the history of the people themselves, their industries, their manners and customs, and, in short, of all that constitutes the character of a nation as distinct from the mere annals of its Princes and Ministers.

The first number of the *Penny Magazine* contained that compiler's jewel, Dr. Dod's Sermon on Malt, at which the honest workers on the *Mirror* did not grow pale; while Knight himself acknowledged the *Mirror* to have "gone on improving from year to year."

Mr. Knight had the consolation that he was really ministering to the public good while he bore up, unaided, under the heavy load of the *Penny Cyclopædia*. This he carried on to its close, through twelve long years, but at a heavy loss, on account of its being overweighted by the heavy "taxes on knowledge," for the repeal of which he fought so manfully and gallantly. The title of the *Cyclopædia* was a mistake—a miscalculation, for which no probable sale could repay—an opinion which Mr. Pickering, the eminent publisher, expressed in our hearing, though he admitted that the literary and scientific value of the *Penny Cyclopædia* was superior to that of any other work of its class. Mr. Knight expended on the *Penny Cyclopædia*, for literature and engravings, the large sum of 42,000*l*., and in producing which he had to pay the Excise no less a sum than 16,500*l*. "Now that the taxes on knowledge are abuses of the past, it seems scarcely credible that the producers of the soundest and most beneficial literature were only a few years subject to such exactions. It is even more wonderful that, in the face of so extortionate a law, a man could be found brave and hopeful

enough to begin and finish such a work. Of course, all that the publisher said so forcibly in proof that the commercial failure of his *magnum opus* was due to pernicious law, is also a demonstration that under the circumstances the work ought never to have been undertaken." This opinion, so sagaciously expressed in the *Athenæum*, was doubtless the conclusion of the majority of the three hundred guests who dined together at the Albion Tavern to celebrate the completion of Mr. Knight's herculean labour, with Lord Brougham in the chair.*

We have referred to Mr. Knight's *Pictorial History of England*, which was contributed by several eminent hands. But he had long contemplated the production of a *general* History of England, on a more comprehensive scale, and in his extensive reading he had gathered materials for a comprehensive *History of the People*. The remarks of *the Times*, however, in 1854, led him, as he tells us,—

"To depart from the original design of writing a domestic history of England apart from its public history. Upon a more extended plan," he adds, "I would endeavour to trace through our long-continued annals the essential connection between our political and our social history. To accomplish this, I would not keep the people in the background [as is done in many histories], and I would call my work the *Popular History of England*."

Mr. Knight eloquently writes in reference to this subject:—

"The people, if I understand the term aright, means the Commons of these realms, and not any distinct class or section of the population. . . A century of thought and action has widened and deepened the foundations of the State. This, 'People,' then, want to find, in the history of their country, something more than a series of annals, either of policy or of war. In connection with a faithful narrative of public affairs they want to learn their own history—how they have grown out of slavery, out of feudal wrong, out of regal despotism, into constitutional liberty and the position of the greatest estate of the realm."

This work has been truly described as "a considerable performance;" but it is open to the objection that its main object has been overwrought, it being *too popular*. Whoever reads the list of contributors to the *Penny Cyclopædia* must be convinced that Mr. Knight assembled round him workers of first-rate authority. His three autobiographical volumes were less attractive than the majority of his works; the six volumes of Knight's *London* were of unequal value, and the master-hand in them less evident. "In his transactions," says the *Athenæum*, "he was conscientious and honourable; and under the difficulties and vexations that attended his greatest labour, he was nobly considerate towards his literary coadjutors. He was a man of many friends; and every one of them—now living in this land—was touched by the intelligence that a blow long expected and long delayed had at length fallen, and that Charles

Knight had died in his eighty-second year, at Addlestone, Surrey. As Charles Knight was one night retiring from the table of "Our Club," Douglas Jerrold described the man in two words, when, with a twinkling eye and tender voice, he said, "Good Knight."

Nearly the first half of Mr. Knight's life was passed at Windsor, of which he has left many pleasing reminiscences of the country when George the Third was King. He had travelled extensively in England, Scotland, and Ireland, with open eyes and ears, and thereby gained opportunities of observing the actual condition of the people. These he turned to good account in his valuable work, entitled *The Land We Live In*. Hence, he wrote of the country as one of the country; and, in after life, he mostly resided in the suburbs of the metropolis, to the beauties of which he was more alive than most Londoners. He loved to dwell at Hampstead or Highgate; and at Addlestone he shuffled of his mortal coil: he sleeps at his native Windsor, where a lich-gate has been erected by public gratitude in memory of a most useful and laborious life, the fruits of which are to be seen in the literature and social condition of our age.

Sir Francis Pettit Smith, inventor of the screw mode of propulsion. He was born at Hythe, in Kent, on Feb. 9, 1808, and at his death he had just completed his sixty-sixth year. He began life as a grazing farmer in Romney-marsh, whence he removed to Hendon, Middlesex. During his early manhood he constructed numerous models of small boats, for which he contrived various modes of propulsion. In 1834 one of these models, propelled by a screw revolving beneath the water at the stern of the vessel and set in motion by a spring, was found to answer so well that Mr. Smith deemed the screw to be superior to paddles, which hitherto had been exclusively employed for the propulsion of vessels. He continually improved upon this model, and in 1836 took out a patent for his "screw." In that same year a small vessel of ten tons burden, fitted with a screw, was built; and in 1838 the *Archimedes*, of 237 tons burden, similarly fitted, was launched, and proved a great success. The Admiralty after a while adopted the screw in Her Majesty's Navy, and private owners shortly recognised its value for the merchant service. A House of Commons Return shows that up to the end of the year 1869, 578 ships of all classes in the Royal Navy and 1,720 in the merchant service, had been fitted with the "screw," and that the total cost of these vessels exceeded 108,000,000*l*. Nevertheless, the difficulties of all kinds with which at first Mr. Smith had to contend in introducing the "screw" were prodigious, and such as would have daunted most men. But an unshaken confidence in the correctness of his views upheld him against all opposition. While, however, Mr. Smith rendered such important services to his country, he was pecuniarily a loser. It is true that Her Majesty, on the recommendation of Lord Palmerston, in 1855,

granted Mr. Smith a pension from the Civil List of 200*l.* a year, in consideration of his personal services to the Navy, and in 1871 conferred upon him the honour of Knighthood; but these recognitions by Government of Sir Francis' valuable and continuous services during the best years of his life but inadequately recompensed him for his distinguished achievement. In 1857, at a public banquet in St. James's-hall, a service of plate and 2,678*l.*, the result of a national subscription, were presented to Mr. Smith. For thirteen years prior to his death Sir Francis held the post of Curator of the Patent Office Museum, South Kensington. He was buried privately, according to his wish, at Brompton Cemetery. Sir Francis P. Smith was twice married, and his widow and two sons survive him. It is to be hoped that the Civil List Pension will, in consideration of his very eminent services to the country, be continued to his widow.—*Times.*

JOSEPH S. WYON, medallist, who held the appointment of Chief Engraver of Her Majesty's Seals. This appointment had been previously held by his father, Mr. Benjamin Wyon, and by his grandfather, Mr. Thomas Wyon, upon whom it was first conferred in the year 1816. The lately deceased artist was educated by his father, Mr. Benjamin Wyon, and in the Royal Academy of Arts, where he obtained two silver medals. His first work of importance was a medal of James Watt, the inventor of the steam-engine. This medal so pleased the late Robert Stephenson that, at his recommendation it was adopted as an annual prize medal by the Royal Institute of Civil Engineers. The first work by the late Mr. J. S. Wyon, executed in his capacity as Chief Engraver of Her Majesty's Seals, was the Great Seal of England now in use. In the year 1863 he executed the medal struck by order of the Corporation of the City of London to commemorate the passage of the Princess Alexandra through the City previous to her marriage with his Royal Highness the Prince of Wales, and in the year 1867 the medal for the same corporation to commemorate the visit of the Sultan. In the latter year he executed the medal struck by order of the Canadian Government to commemorate the Confederation of the four Provinces of the Dominion of Canada. The Great Seal of the Dominion of Canada, a beautiful work of art, was also executed by him at the same time.

Memorabilia.

[We have the pleasure of acknowledging our indebtedness to the *Builder* for the following very interesting artistic document.]

THE NATIONAL MEMORIAL TO HIS ROYAL HIGHNESS THE PRINCE CONSORT.

WITH this title we have a large, costly, and beautiful book, which gives a history of the National Memorial erected in Hyde Park, describes the construction, and illustrates every portion of it, both as to colour and form, in a complete and very admirable manner. It is not too much to say that every Englishman is interested in the circulation of this volume, which will serve to convince all who study it, and who may not be able to visit the monument itself, that the finest modern work of its kind has been produced in this country, and that we have amongst us artists (as well as constructors) of high ability.

It is a distinguishing feature of the book before us that the name of every artist is given in connexion with his work, which should, and we hope will, have the effect of bringing to some of them increased fame and fortune. We would point for example to the remarkable histories written with the chisel on the marble podium, half by Mr. J. Birnie Philip and half by Mr. H. H. Armstead the first setting forth the architects and sculptors; the second the painters, poets, and musicians; producing a whole honourable alike to the country and the artists, both as regards conception and execution.

This, taken as a whole (says Sir Gilbert Scott), is perhaps one of the most laborious works of sculpture ever undertaken, consisting, as it does, of a continuous range of figure-sculpture of the most elaborate description in the highest alto-relievo of life-size, more than 200 ft. in length, containing about 170 figures, and executed in the hardest marble which could be procured; each figure, not cut, as is usual, out of a detached block, so that every portion can be easily reached, and the waste stone readily struck off, but, on the contrary, hewn out of the solid mass of the monument, just as if the forms were cut out of a solid rock of marble; so that every opening between figures, or between parts of them, became a work of unusual cost and labour. We can bear testimony to the zeal with which both the sculptors, Mr. Armstead and Mr. Philip, persistently carried on their several proportions of the work, though they found a difficulty in respect of the great hardness of the marble, not calculated on when they made their original estimates as to cost.

The last timber of the scaffolding was taken down on the 31st of March, 1871.

When this was done, the iron tie-rods between each arch

became visible, and an impression prevailed that these rods had only just been introduced as a precaution against thrust. They had, however, been fixed in 1866, whilst the arches were being turned, and it was thought to be more satisfactory to allow them to remain for a time after the centreing had been removed in case any tendency to subsidence or thrust might appear, though from the peculiar arrangement by which the spire is carried, such a contingency was not considered to be at all probable. Each of these rods consisted of two pieces of iron joined together in the centre by a large screw-nut; they were tested from time to time, but no tension was ever observed. They appeared to be affected only by change in the atmospheric temperature. After remaining in position for nearly five years, they were removed in April 1871.

The central portion of the monument is based upon a mass of concrete, 60 ft. square and 27 ft. in thickness; indeed, in some parts it is of much greater thickness, owing to the inequalities in the solidity of the ground. Upon this are laid two continuous courses of thick stone landings, bedded in Portland cement, and on this platform is erected the superstructure of massive brickwork upon which the monument is based. The substructure which supports the steps and landings surrounding the monument, though planned simply with a view to their practical uses, form a curiously intricate and picturesque series of catacombs, which may be entered by a trap-door provided beneath the surrounding platform.

The materials of which these steps are formed is mainly the grey granite from Castlewellan, in the county of Down, the same granite being used for the large pedestals at the angles of the steps; a portion, however, of the steps came from Dalbeattie quarries, in the county of Kirkcudbright.

Owing to the slope of the ground towards the south, an additional range of steps was required on that side leading down to the drive in front. These steps—no less than 200 ft. in length—are of granite from Penryn, in Cornwall, while the blocks which terminate them are of the same granite, capped with the pink granite from the Isle of Mull. The landings of the steps are paved with stone of varied colours, consisting of the white mountain limestone of Hopton Wood, in Derbyshire; the red magnesian sandstone from Mansfield, in Nottinghamshire; and the dark slate stone from Charnwood Forest, in Leicestershire.

The granite up to the levels as yet alluded to is unpolished, but wrought by the axe with extreme delicacy and precision. Above this level, however, all the granite which is exposed to view is finely polished, and has been studiously selected in point of colour and texture, with a view to the harmony of its artistic effect.

The podium, or stylobate, which forms the base of the great canopy, and to the carving on which we have already alluded is of two kinds of granite, and of marble. Its base-moulds, 3 ft.

in height, are of a single course of the richest red granite from the Ross of Mull, and the cornice, 2 ft. in height, is of a lighter-coloured variety from the same locality, both wrought and polished with the greatest care and precision. The intermediate portion, which is of marble, and is occupied entirely by sculpture, is 6½ ft. in height in a single course.

The construction of the four main clusters of shafts which carry the canopy was of course all-important. These do not trust alone for their bond of union to the metallic band which binds each cluster. Each of the four greater shafts (which are about 2 ft. in diameter) is attached by a dovetailed groove to the central core, and the grove is run in solidly with Portland cement. Besides this, there is another very important method of attachment; for, while the shafts are jointed behind the metal band at about one-third of their height from the base, the core is jointed at about the same distance from the capital, thus, as the workmen say, *breaking joint*; the longer length of one crossing and strengthening the joint of the other, while the joint in each is attached to the side of the other by strong copper cramps, and each block is also plugged with four copper dowels to that below and above it; so that the entire group is, as it were, in one piece.

The spire, which surmounts the stonework, is wholly of metal, and is supported by two enormous "box" girders of wrought-iron. Each girder lies diagonally from corner to corner of the structure. They may, perhaps, be more truly described as *one* girder in the form of a cross, for at their point of intersections they are so united by the interlacing of their component parts as to become in reality a single girder. The girders are in section, 3 ft. 4½ in. in depth, by 3 ft. 6 in. in width; their length each way is 31 ft. 6 in., and their clear bearing 23 ft. 6 in. Their weight is 23 tons, and it is calculated that they are capable of sustaining a load equal to 360 tons. The ends of the girders rest upon vast blocks of granite, which being laid across the angles of the structure, tend to bind its walls together, and to carry down its weight directly and vertically upon the columns. How the amount of iron used in the construction may behave in the course of time is a problem not yet to be solved.

The architectural carving was carried out by Mr. Brindley. Sir Gilbert says:—"The capitals of the great piers are, as I think, very effective work. They are founded on such as we find in ancient buildings in France and Germany, and such as we see in this country; in the eastern parts of Canterbury Cathedral—a form of capital originating in the Corinthian, but entirely rethought out by the great Mediæval artists. The arches are, in some of their divisions or orders, beautifully carved with pierced foliage in high relief, thus obtaining effect by contrast."

A very important part of the monument is the artistic metal-

work, the whole of which was carried out by Mr. Skidmore. "It is here (says the architect) that my thought of realising on a large scale the ideal of the old shrines comes literally into practical operation; for here the classes of art and ornamentation displayed in those exquisite works on a minute scale, suggesting only the models of some large structure, are directly reproduced in cognate materials, and to a scale of reality instead of mere miniature models. The materials in which the works of the Mediæval gold and silver smiths are thus translated, as it were, into life-size, are copper and lead, and in these humbler metals are reproduced in noble workmanship, and to a noble scale, the *repoussé* work, the chased and beaten foliage, the filagree, the gem-settings, and the matrices for enamels, such as are found in the shrines of the Three Kings, or of St. Elizabeth. No nobler work in metal for architectural purposes has, so far as I know, been produced in our own, or, probably—considering its scale and extent—in any other age." And the architect then pays a high compliment to Mr. Skidmore. We have only to add in this direction that the mosaics in the tympans and spandrels, also the vault of the canopy, were executed by Signor Salviati, after cartoons by Messrs. Clayton & Bell.

Now, as to the sculptural works not already alluded to, the general scheme may be thus stated:—The great statue of the Prince Consort himself, by Mr. J. H. Foley, forming the central feature, round which all other works of art group themselves, we have at the angles four ranges, each containing four illustrations of subjects to which the Prince had devoted his study and patronage.

1st. On the pedestals at the outer angles of the steps we have groups of figures in marble, representing allegorically the quarters of the globe, with reference to the Great International Exhibitions which have done so much for practical art and manufactures and the productions of varied industry, and which claim the Prince Consort as their originator. These were executed by Mr. J. H. Foley, Mr. Macdowell, Mr. W. Theed, and Mr. John Bell, and are noble works.

2nd. We have on the upper pedestals, which form the angles of the podium, groups, also in marble, illustrating Commerce, Agriculture, Manufactures, and Engineering, all furthered and promoted by International Exhibitions: these are by Mr. Thornycroft, Mr. Calder Marshall, Mr. Henry Weekes, and Mr. John Lawlor.

3rd. The great pillars of the Memorial bear on their outer faces—on pedestals of polished granite and bronze—statues in bronze, representing Astronomy, Geology, Chemistry, and Geometry; while

4th. On the niches immediately over the capitals of these pillars is a second range of bronze statues, representing Rhetoric, Philosophy, Medicine, and Physiology. The whole of these were executed by Mr. J. B. Philip and Mr. Armstead.

These groups and statues, which occupy the four *angles* at successive heights, thus illustrate the whole range of science, and of practical art and industry.

Some of the bronze gilt statues in the spire, designed by Mr. James Redfern, are very beautiful.

We are glad to find that Mr. Murray has supplied an omission in his first published smaller account of the Memorial by printing the names of the Mansion House Committee, by whom important work was done.* It was the privilege of the conductor of the *Builder* to co-operate with some half-dozen other gentlemen deputed to act for the general committee (as it also had been his privilege in raising the Memorial of the Great Exhibition of 1851 at South Kensington), so that we speak from personal knowledge when we record the zeal and loyalty with which the original committee long and sedulously worked.

The Memorial bears the following dedicatory inscription, executed in mosaic work, and which may fitly end our notice. It runs round the structure, and is so divided that each side shows a complete sentiment:—

QUEEN VICTORIA AND HER PEOPLE
TO THE MEMORY OF ALBERT PRINCE CONSORT
AS A TRIBUTE OF THEIR GRATITUDE
FOR A LIFE DEVOTED TO THE PUBLIC GOOD.

MEMORIAL HALL TO THE LATE GEORGE STEPHENSON.

The Hall proposed to be erected to the memory of the late eminent engineer, George Stephenson, at Chesterfield, will now, it is believed, be carried out. The hall, to be erected within view of the churchyard where the remains of George Stephenson rest, will be opposite to his residence, Tapton House, and close to the Midland Railway, which he perfected and completed, as well as to the Lockford Colliery, which was sunk and worked by him. A joint committee, consisting of members of the Corporation of Chesterfield, of the Chesterfield and Derbyshire Mining and Mechanical Engineers' Associations, of the Mechanics' Institute, and of the Technical Education Society, has been formed for arranging the preliminaries. The Corporation have offered as a site about 2,600 square yards of land in the town, now used as a bowling-green, provided that the legal estate in the land and buildings to be erected by the various societies be vested in the Corporation upon trust for a Board of management consisting of representatives of the Corporation and the societies. The cost of the building, which is to consist of a large hall, library, and reading and class rooms, has been estimated at from 12,000*l.* to 14,000*l.*—*Builder.*

* The closing Report of this Committee, forwarded to her Majesty in October 1872, will be found in the *Builder* for that year (xxx. p. 909). It is signed—"George Godwin, chairman; Charles Hill and P. Le Neve Foster, members of the executive committee; Michael Gibbs and S. H. Goodman, honorary secretaries."

THE WELLINGTON MONUMENT.

The following is a copy of the last Report to the Treasury on the subject of the Wellington Monument, dated June 6th:—

"We have the honour to inform your lordships that the progress of the works connected with the Wellington Monument was stopped for some time in consequence of the serious illness of Mr. Stevens. We learnt recently that Mr. Stevens was convalescent and again at work on the monument, and we therefore felt it our duty to inspect the works, and we now beg leave to lay before your lordships the following Report of the present state of the monument. The whole of the marble-work is completed and fixed in St. Paul's Cathedral, and nearly all the bronze-work appertaining to the marble has been cast and fitted; but some portions of this bronze-work have been taken back to Mr. Steven's studio for the purpose of being finished off by him. The sculptures comprising the following portions of the monument—viz. the effigy of the Duke, the sarcophagus on which the effigy is to repose, and the two side groups for the upper part of the monument—have not been much advanced since the contract was entered into with Mr. Coleman. One of the side groups, in two pieces, has been removed from the large model; one portion of the group is in plaster, and being worked upon by Mr. Stevens; the other portion is in clay only, still unfinished. The other side group and the effigy of the Duke still remain on the model unfinished. Plaster moulds of the sarcophagus and its enrichments have been made, but they still require the work of the sculptor to prepare them for casting. Mr. Stevens informs us that his assistants cannot help him in preparing the models of the sculptures for casting, and therefore the time that will be required for their completion will depend upon Mr. Steven's personal labour. Mr. Stevens estimates that the figure or group upon which he is now working will require two months of his labour, and that each of the other models will require a like period, making in all from eight to ten months for his own work before the last of the models will be ready for casting. Assuming this estimate of the time required by Mr. Stevens to be approximately correct, and assuming that the founder will be put into possession of each model as it is finished, probably three months will have to be added to the above eight or ten months for casting the last model, and a further allowance must be made for finishing off and colouring the bronze sculptures and for placing them on the monument. Having regard to the experience of the past, we cannot place much reliance upon Mr. Steven's estimate of time for completing the models; and if the present rate of progress is to be maintained, we cannot hold out any hope that the monument will be finished by the end of 1874, though at the same time, if Mr. Stevens should be able to exert himself with greater effect the work might possibly be completed at an earlier period."

GENERAL INDEX.

THE YEAR-BOOK OF FACTS IN SCIENCE AND ART.

(*From the "Builder,"* 1873, p. 254).

Once more Mr. Timbs embalms for the popular eye the most recondite fruits of the year's progress in science and art amongst the adepts, much of which might otherwise not be seen or heard of for years, if at all, by the public. And yet Mr. Timbs is not seldom taken to task by hypercritics because he is not the author, but only the editor, as a rule, of some of his most useful books. But of what worth, compared with this volume, would such a book be, even were it *written* by the hypercritic himself? It is the *ipsissima verba* of men of science and of arts which constitute its value.

The interest of the volume is as varied and great as it has been any year during the last quarter of a century, or at least since the origin of this standard work.

Appendix.

DYNAMITE. (*See* pp. 33–35).

THE *Glasgow Herald* gives an account of a number of experiments in 1874 performed in the woods and fields on the Cadder estate of Sir William Stirling Maxwell, and near the Forth and Clyde Canal, on the farm of Mr. John Murdoch, of Hilton. Their object was to show the great utility and advantages of this new explosive substance in the *clearing of land* so as to fit it for cultivation, and they were intended chiefly for the benefit of several gentlemen who are largely interested in land-clearing and agricultural operations in Canada. Before proceeding to do any blasting work, Mr. Downie performed two or three experiments for the purpose of illustrating the conditions that must be observed in order to do any such work with dynamite. Having shown that the ordinary method of inducing explosive action in gunpowder was not sufficient to bring about an explosion of dynamite, Mr. Downie mentioned that the new explosive had this peculiarity namely, that it would only do its work—that of decomposing with explosive action—when it was powerfully percussed, and that the ordinary method was to explode some detonating or other explosive substance in contact with it. Specially prepared and extra-powerful percussion-caps are the agents used to induce the explosion, and with these it is customary to use, especially in water-bleeding rocks and in subaqueous blasting operations, a suitable length of Bickford's fuse, which consists of a line or thread of gunpowder, encased in a tube of gutta-percha, by means of which the water is effectually excluded from the gunpowder. One of the caps was tightly squeezed upon the end of a piece of fuse, and, the other end of this being ignited, the whole was thrown upon the ground; in a few seconds, when the fire was conveyed by the gunpowder to the fulminating powder in the cap, there was a very sharp and powerful detonation.

After performing these preliminary and somewhat elementary operations, Mr. Downie turned his attention to the root-stumps of a number of trees that had recently been cut down. By means of an auger, a hole about one and a quarter inches diameter was bored vertically to a depth of 12 or 15 ins. in one of the stumps, and when it was found to be quite through the wood of the stump it was continued by means of a pinch to a depth of fully 2 ft. Two or three cartridges were put into the bore-hole and firmly driven home by means of a wooden rammer. Then a small cartridge called a "primer," prepared with a cap-tipped fuse, was dropped in and rammed home, and the hole was tamped or stemmed by filling it to the top with water, care having

in this case been taken to put a luting of clay round the junction of the cap with the fuse. The latter was fired, the observers betook themselves to a respectful distance, and in a brief space of time a great upheaval occurred. The noise of the explosion, however, was in a great measure smothered. When the members of the party returned to the spot they found the stump to be rent in a most extraordinary manner; but the general opinion was that the bore-hole had been made so deep that the energy of the explosion had spent itself too much upon the subsoil and too little upon the wood. The stump next operated upon was bored to a less depth, and the result of the blasting process was more effective. In either case a few strokes with an axe, by way of severing the principal root-members, would be quite sufficient to leave the woody masses in such a condition that they could easily be dragged out and lifted away. It was suggested that the operation of piercing with an auger should be dispensed with in blasting the next root-stump, so as to do the work with as great economy of time as possible. In this instance, therefore, the pinch was brought into requisition instead of the auger, and by means of it a hole was driven horizontally inwards, between two of the principal root-members, to about the centre of the stump. The hole was charged and fired in the usual way, the result being a much greater amount of eruptive and disruptive action, with a smaller expenditure of time and labour. One or two other root-stumps of large size were blasted in the same way, and it was clearly demonstrated that, under certain circumstances, dynamite could be employed to more advantage immediately underneath rather than in the mass of material to be operated upon. The next experiments were with boulder-stones, all of which were of very hard, tough, and compact whinstone. The first boulder that was tried was out in "the open." One small cartridge, properly prepared, was laid on an inclined face of the stone, then covered loosely with a sod, and fired. No rupture resulting from the shot, another was resorted to, a shallow groove on another part of the boulder being selected for laying on the charge. The latter was loosely covered, as before, and fired, and such persons as had not seen a similar experiment previously were greatly surprised at the destructive effect of the explosion, when the small amount of the charge was considered, together with the fact that no bore-hole was driven into the boulder. Other two large boulders were next attacked in an adjoining field that was being drained, the stones having been met with in digging the drains. The first of them was embedded in tolerably firm ground, and on being fired *in situ*, without any bore-hole, was almost crumbled into dust. Owing to the fact that the other boulder was embedded in a deposit of sand, the small charge of dynamite used at first seemed to have spent itself in burying it to a much greater depth in the sand; but on employing a somewhat larger charge, besides being buried still deeper in the sand, the boulder was so thoroughly broken that

it, might well have been used for road metal, Mr. John Scott, of the Glasgow Canadian Land and Trust Company, after seeing the experiments, said he could use the new blasting agent with great effect and economy in land-clearing operations in Canada.

CHANGES IN THE STANDARD OF VALUE.

THE Deputy Master of the Mint, in his annual Report, observes that the year 1872 was remarkable for the movement, occurring in various countries, towards a reorganisation of coinage arrangements, and the adoption of gold as the sole standard of value. In the United States the laws relating to the coinage have been for some time under consideration, and Congress has had before it a Bill constituting the gold dollar the unit of value, and omitting all mention of the silver dollar, which has hitherto held its place in theory as a standard coin. This Bill, which became law on the 1st of April, 1873, thus abolishes the double standard, and places the United States among the nations following the example set by this country in 1816, in the adoption of a single measure of value, and of gold as that measure. The coinage of gold in Germany has been carried on with energy, and to the value of about 30,000,000*l.* sterling, but the coin has not yet been issued for general circulation, and it was not until the present year that a Bill was introduced into the Reichstag establishing gold as the sole standard of value, and containing provisions for the demonetization of the silver and the regulation of the bronze coinage. Under this law the seignorage to be levied on the silver token coinage—viz. 11·111 per cent.—will considerably exceed that imposed in England or France, which is about 9 and 7·784 respectively. The official trade accounts of Bremen for 1872 express the values for the first time in marks instead of Bremen thalers. Bremen claims to be the first German State which has introduced the new monetary system based upon the mark as a unit on the gold standard. The mark is the tenth part of an imperial gold coin, 133½ pieces of which are to be coined out of 1lb. of pure gold; the mark to be divided into 100 pfennings. Comparing the new coin with the old Bremen coin, a 20-mark piece is stated as equal to 9 thaler, 210·31 grote, Bremen currency, which latter currency has now been abolished, and is taken out of circulation. Until the new system shall be in operation in all the German States, the Prussian thaler will serve as a circulating medium, one thaler being considered equal to three marks. In view of the contemplated changes in the German currency, the Dutch Government has considered the position of Holland in regard to her single silver standard, and in October a Royal Commission was appointed to inquire into the subject. The report of this Commission recommended the immediate provisional introduction of the double standard of gold and silver, and the provisional suspension of the coinage of silver standard

money. Steps having been now taken for the introduction of the single gold standard throughout the German Empire, the Dutch Government have suspended the coinage of silver until November, 1873, and, should the views expressed by the Royal Commission prevail, will probably abandon the silver standard altogether. In the Scandinavian Kingdoms also steps have been taken for the adoption of the gold standard. An International Commission, comprising delegates from each of the three Governments of Sweden, Norway, and Denmark, met at Copenhagen last summer to consider the subject, and reported that, though anxious to devise some scheme by which the three States could join one or other of the great monetary systems of Europe, apparently insuperable obstacles to such a course had led the Commission reluctantly to recommend a less comprehensive measure, applicable to the three northern kingdoms only. Delegates from the three countries again met at Stockholm in November, and on December 18 a convention was signed, declaring that the three kingdoms adopt gold as the basis of a common monetary system, silver and other inferior metals serving for the subsidiary coinage. The "crown," which is constituted the common unit of account, is to be 1·248th part of a kilogramme of fine gold, and its value, therefore, about 1*s*. We may add here that a report made to the French National Assembly by a Commission last year gave some interesting information as to the bronze coinage now in circulation in France. It appears that the authorised circulation of bronze coins in France is equal to no less than 61,500,000f., or 2,460,000*l*. Of our own bronze coin, the total issued for circulation in the United Kingdom and the colonies in which the Imperial coinage is current, was only 1,099,000*l*. at the end of the year 1872.

FOREIGN MEASURES AND ENGLISH EQUIVALENTS.

We notice that a very useful pamphlet has been recently published, containing a series of tables for the conversion of weights and measures, money, &c., into English or foreign equivalents. There are altogether thirty tables, the first four of which are for the reduction of French into English money, and *vice versâ*. Tables Nos. 5 to 9 are for the changing of avoirdupois units into kilogrammes, and of kilogrammes into tons, hundredweights, quarters, and pounds, and the four following are for the conversion of measures of length into French or English equivalents. A similar series is compiled for German measures, and a third for those in use in Russia, while an appendix is added containing tables of decimals of a ton and hundredweight carried to four places of decimals, with others for converting kilogrammes into English weights, carried out to a greater degree of precision than those in the body of the pamphlet, although the latter are all exact enough for practical

purposes. The tables are all very clearly and simply arranged, equivalent values of the money, weight, or measure to be converted being arranged in vertical columns of units, tons, hundreds, &c., so that the process of conversion becomes simply a matter of addition. This little work has been prepared by Mr. John C. Duncan, Secretary of the Atlas Steel and Iron Works, Sheffield (John Brown and Co., Limited), especially for the use of their works.

STANDARD WEIGHTS AND MEASURES.

The Warden of the Standards states, in his Report on the financial year 1872-73, that no less than 565 standard weights and measures were rejected in that year for bad workmanship, or as requiring re-adjustment, being 20 per cent., or one in five, of the whole number sent for verification. Attention is drawn to the comparatively large number of 1lb. avoirdupois weights rejected; he attributes this not only to a relatively smaller amount of error being tolerated, but to the 1lb. weights being adjusted by weighing them in a balance fit only for testing larger weights. His attention has been called to the fact that the workmen employed in the adjustment of weights and measures are, as a rule, inferior in education and general intelligence to men employed in the manufacture of other instruments of precision, such as in opticians' or watchmakers' work; this, he thinks, may be attributed to a deficiency in technical knowledge, as, although they may be skilled in the purely mechanical part of their trade, they appear to know little beyond it. In point of fact, he says, generally speaking, everything is sacrificed to the attempt to make weights and measures as cheap as possible. Rejections for inadmissible errors occur more frequently with the weights, and for bad workmanship in the measures; and it happens much more often than it ought that the same local standards are rejected as erroneous, not only once, but twice, and even three times or more. In measures the scale of errors allowed is limited to 280 grains weight of water in a bushel, 50 in a gallon, 10 in a pint; 0·01 inch in a yard. In avoirdupois weights the allowed error is 5 grains in excess or 2·5 in deficiency in 56lb., and 0·25 grains in excess, or 0·125 in deficiency in 1lb. Since the Act of Parliament of 1859 the Warden has verified, in the 14 years, 10,719 standard weights and measures for the first time, besides 174 gas measures; and 21.446 have been re-verified. But there are in the United Kingdom 26 counties and 77 boroughs where the standard weights have not been re-verified within five years, as required by law, and 19 counties and 51 boroughs where the standard measures of length and capacity have not been re-verified within the ten years limited for that purpose by law. These numbers of defaulting places are large, but they are subject to some correction.

RUSSIAN WEIGHTS AND MEASURES.

Among the collection in the old Norman Jewel Tower, Old Palace-yard, there are copies of Russian standard weights and measures, which were sent to this country by the Russian Government for the International Exhibition of 1862, under the charge of the late M. Kupfer, the eminent member of the Imperial Academy of Sciences at St. Petersburg, and were afterwards left at the disposal of the late Mr. James Yates, who in 1869 presented them to our Standards Department of the Board of Trade. There are two standard weights made of iron and of spherical form, with a knob. The smallest is a Russian *funt*, or pound, and now weighs, in comparison with our avoirdupois standards, 14oz. 7dr. 5·2gr., or 6,319·85 grains. The larger weight is a *pud* of 40 Russian pounds; it weighs 36lb. 1oz. 12dr. 5gr. avoirdupois, one fortieth part of which is equal to 6,319·26 grains. The Russian standard pound is stated by M. Kupffer to be equal to 0·90283 avoirdupois pounds, or 6,319·81 grains. It is divided into 96 sol. and each sol into 96 doli. The dola is found to be equal to 0·68573 troy grains, and 8399·742 doli are equal to a standard troy pound. There are also in the collection four standard measures of capacity, all well constructed of brass and of cylindrical form. No. 1 appears to be a *tchetverik*, the Russian unit of capacity for dry measure, the legal contents of which are 64 Russian pounds of water at 62° F. weighed in a vacuum, or a capacity of 1,601·22 cubic inches. Its diameter is 11½ inches, and depth 15 5-16 inches. Its contents of distilled water are found equal to 405,270 grains when weighed at the temperature of 62 degrees F., and the barometer at 30 inches, or a computed capacity of 1605·3 cubic inches. No. 2 appears to be a *vedro*, the Russian unit of capacity for liquid measure, which ought to contain 30 Russian pounds of water at 62 deg. F. weighed in a vacuum, or a capacity of 750·57 cubic inches. Our copy of this standard measure will contain water weighing 189,388 grains, showing a computed capacity of 750·18 cubic inches. Its diameter is 9¼ inches, and depth 9 15-16 inches. No. 3 appears to be a *chtof*, a customary measure, the eighth part of the *vedro*, with a legal capacity of 93·82 cubic inches; the actual capacity is found to be 93·74 cubic inches. No. 4 appears to be a *crouchka*, one of the legal decimal measures, equal to one tenth of a *vedro*, or containing 75·057 cubic inches; the actual capacity is found to be 75·087 cubic inches. There is also a copy of the *archine*, which is practically the Russian standard of length. This is a flat brass slip 25¾. long, ¾in. broad, and about ⅛in. thick, a single screw in the middle securing it in a groove of a brass bar of the same length. A scale engraved on the slip divides the *archine* by lines into 16 *verchocs*, and the foot into 12 inches. A careful comparison with our bronze standard yard gives the length of the *archine* at 67 deg. F., 27·99999116 Imperial inches, and of

the foot 11·99939514 Imperial inches. The Russian standard of length is derived from the British standard yard. By a Ukase of Peter the Great the *sagène* of 7 English feet was established as the legal standard of length. The *archine*, the third part of the *sagène*, is equal to 28 English inches, and the Russian foot is the same as the British, or 12 inches of the Imperial standard yard of 36 inches. It will be seen from the above measurements that our two copies of the Russian standards of length are very accurate measures.

THE WHITWORTH SCHOLARSHIPS.

THE following Memorandum on the Whitworth Scholarships, prepared by Sir Joseph Whitworth, has been approved by the Lords of the Committee of Council on Education, South Kensington:—1. The experience of the past competitions for my Scholarships has proved to me the necessity of establishing rules which shall insure that the holders of Scholarships shall devote themselves to the studies and practice necessary for mechanical engineering, during the tenure of the Scholarships. 2. To effect this, I propose to the Lords of the Committee of Council on Education that as soon as possible, *i.e.* in the competition of 1875, every candidate for a Scholarship shall produce a certificate that he has worked in a mechanical engineer's shop, or in the drawing office of a mechanical engineer's shop, for two years consecutively. In 1874, six months' consecutive work only in the engineer's shop will be required. The candidate must be under 22 years of age. 3. The candidate for the Scholarship will be examined in the appointed sciences; in smith's work, turning, filing, and fitting, pattern making, and moulding, as already established, and the same marks will be awarded as at present. 4. In 1875, and the following years, each holder of a Scholarship appointed under these new rules will be required to produce satisfactory evidence at the termination of every year that he has made proper advances in the sciences and practice of mechanical engineering, by coming up for an examination similar to that which is prescribed for the competition both in theory and practice. 5. The Scholarships may be held for three years, but may be withdrawn at the end of each year if the scholar has not made satisfactory progress. 6. The number of Scholarships in the competition of 1874 will be reduced from ten to six. Each Scholarship will be of a fixed annual value of 100*l.*, together with an additional sum determined by the results of the progress made in the preceding year. 7. At the end of each year's tenure of the Scholarship, the scholars appointed under these new rules will, as before stated, be examined in theory and in practice in the same manner as in the competition for the Scholarships. On the results of this examination the following payments, in addition to the 100*l.* before mentioned, will be made among each year's set or batch of scholars. To

the scholar who does best in the examination, 100*l.*; to the second, 60*l.*; to the third, 50*l.*; to the fourth, 40*l.*; to the fifth, 30*l.*; and to the sixth, 20*l.*; provided that each scholar has made such a progress as is satisfactory to the Department of Science and Art, which will determine if the sum named, or any other sum, shall be awarded. 8. At the expiration of the three years' tenure of the Scholarships under these new regulations, a further sum of 300*l.* will be awarded in sums of 200*l.* and 100*l.* to the two scholars of each year's set or batch who have done best during their tenure of Scholarship. In this way it will be possible for the best of the scholars at the end of his period of tenure of the Scholarship to have obtained 800*l.*, and the others in proportion. 9. The prizes under division 7 will be awarded according to the total number of marks obtained by the students in practice and theory in the examination at the end of the year. The prizes under division 8 will be awarded by adding together the marks obtained by the students at the end of each of the three years.

The following Minute has been passed by the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education: —"Read and approved, the following memorandum on the Whitworth Scholarships, prepared by Sir Joseph Whitworth. 'The Whitworth Scholarships. I wish that candidates for my Scholarships in 1874, who owing to the shortness of the notice may not have been able to be in a mechanical shop for six months before the competition takes place, should be allowed to compete; but that, if successful, their Scholarship should not begin until they have worked six months in a mechanical shop. I think the same privilege should be accorded to candidates in 1875, who have not served eighteen months in a mechanical shop, the Scholarship not beginning until this period is completed.'"

THE ZODIACAL LIGHT.

(*By a Correspondent of "Nature."*)

It is a matter for regret that with the magnificent opportunities of investigating the character of the Zodiacal Light afforded to Maxwell Hall by his elevated position in Jamaica, he does not seem to have brought the powers of either the spectroscope or polariscope to bear on it.

I think the full importance of the inquiry is hardly appreciated by many. Taking the generally accepted theory of the light—that of a lens-shaped disc of luminous matter, with the sun for its centre and a diameter exceeding that of the earth's orbit—its matter, lying as it does in the plane of the elliptic, actually connects us with the sun, and may be the medium through which the solar magnetic forces act upon our own.

The intimate connection between solar outbursts, auroras, and terrestrial magnetism is an established fact.

To the aurora, the zodiacal light is by many conceived to be nearly allied, and I do not think the evidence hitherto adduced against this theory is at all conclusive. The remarkable wave of light seen by Maxwell Hall is strongly in favour of it; and though spectroscopic observations seem to point the other way, they are as yet so scanty in number that it would be as unfair to argue from them the want of connection between the two phenomena, as it would be to assert that the planets have no volcanic fires of their own because they only give us a reflected solar spectrum.

Assume the zodiacal light to consist of solid particles of matter—planet dust—shining by reflected light, and it is not difficult to imagine the aurora playing amongst these tiny worlds, each of which might have its own small magnetic system, swayed like our own by the master magnet, the sun.

So far as my own experience goes I can see no objections to this assumption. Though I have seen the light very brilliant in both its branches, I have never yet found it to have a decided outline. Nor have I been able to trace it either east or west to 180° from the sun. Granting that this can be done, however, the apparent vanishing point of the earth's shadow lies comparatively near us, and far within this again is the point at which the shadow would subtend only a degree or two of arc, and at which it would be very hard to discern mid the feeble light of this portion of the zodiacal light; so that a slight extension of the diameter of the disc would remove any objection that might be raised under this head.

Imagine one of Saturn's moons revolving in an orbit within his belts, and fairly embedded in the matter, which, for the sake of the argument, we must assume to be illuminated by the planet. To inhabitants of that satellite each night would bring a phenomenon closely resembling our zodiacal light, only far more brilliant. At midnight two cones of light would taper upwards east and west, and meet overhead. The brightest portion of each cone would be that along the axis and nearest the horizon. Towards the summit and on the borders, where the line of sight would lie through less depths of matter, the light would gradually fade away, but from the satellite being embedded in the belt, the entire sky would be more or less luminous.

Has it not been noticed on our earth that when the zodiacal light has been seen unusually bright a "phosphorescence" of the sky was everywhere visible? May this not arise from our solar belt in a somewhat similar manner?

From my personal observations I see no reason to give a lenticular form to the disc. Parallel faces would afford a perspective such as the zodiacal light appears to me.

I would urge observers who may be fortunately situated not to neglect opportunities. So far as I am able I shall do my best to aid the work of inquiry, and with the powerful instruments that Browning is forwarding me, placed at an elevation of more

than 6,000 ft., under the clear skies of our Indian winter, I trust I shall be able to add something to our knowledge of the zodiacal light.

I should feel much indebted to any of your readers who would inform me which is the best adapted polariscope for such researches, and whose (amongst makers) speciality such instruments are.

MANUFACTURE OF SHERRY.

Dr. Hassall, in a letter to the editor of *The Times*, says:—"A short time since a very interesting and important correspondence appeared in *The Times* relative to the question of the purity of the sherries consumed in this country. One of your correspondents in particular, Dr. Thudichum, made the statement that all sherries as imported were plastered—that is to say, that the must or juice of the grape, prior to fermentation, was dusted over with plaster of Paris or sulphate of lime, whereby the tartarate of potash of the wine was removed, sulphate of potash being formed and retained in its place, a salt of a somewhat bitter taste and possessing the properties of an aperient. Dr. Thudichum further stated, that the quantities of this salt found in sherry varied from 3lb. to 14lb. per butt of 108 gallons, equal to from 36·1 to 169·2 grains per bottle of one-sixth of a gallon. With a view to test this statement, as well as to determine the question of the purity in other respects of the sherries sold in this country, I have subjected 19 samples to full quantitative chemical analysis, with the results which, with your permission, I will now proceed to record in as brief a manner as possible. Of these 19 samples eight were of the highest quality procurable, and their analysis was undertaken with a view to arrive at certain standards by which the other samples, purchased in the ordinary way from wine-merchants, restaurant proprietors, and publicans, might be compared. The results arrived at were as follows:—

"1. That the whole of the wines, without exception, were fortified with extraneous spirit to a large extent. This spirit, doubtless, in nearly all cases, and probably in every case, is derived either from corn, beetroot, or potato, and not from the grape; while the average amount of proof spirit furnished by the must from which sherries are made at Xeres, according to the best authorities, is about 19 per cent., the lowest quantity found by me was 29·723, and the highest 41·294, the mean of all being 35·477 per cent. In fact, the quantity of spirit added falls not very short of that actually furnished by the fermentation of the grape juice itself.

"2. That 17 of the 19 samples were decidedly plastered. The quantity of sulphate of potash found in the wines, after deducting three grains per bottle—this being the utmost amount ever met with in natural sherry—ranged from 15·0 to 51·6 grains

per bottle. These quantities give 90·0 grains as the lowest, and 309·6 grains as the highest, amount per gallon. It will be seen, therefore, that these analyses bear out the statement of Dr. Thudichum—that all the sherries imported into this country are plastered—that is to say, the must is dusted over with sulphate of lime; in addition to which it is also impregnated with the fumes of burning sulphur, whereby a still further quantity of sulphuric acid is introduced into the wine. Dr. Thudichum gives the quantity of sulphate of potash contained in sherries as varying from 36·1 to 169·2 grains per bottle of one-sixth of a gallon. It will be seen that my highest quantity amounts to 51·6 per bottle, or 309·6 grains per gallon, equal to about three-quarters of an ounce; the quantity of sulphate of potash therefore met with in these analyses is much below the larger amount given by Dr. Thudichum—namely, nearly 2½ ounces.

"3. That, in addition to the fortifying and plastering, five of the wines contained considerable amounts of cane sugar, the presence of which affords, of course, clear evidence of adulteration.

"4. That two of the sherries—those denominated 'Hambro' sherries—contained very little wine at all, but consisted chiefly of spirits, sugar, and water, flavoured; in fact, these mixtures could hardly be said to have any claim to be regarded as wines at all.

"It will thus be seen that, notwithstanding that eight of the samples were of the highest quality obtainable in this country, not one of the 19 wines can be regarded as the pure and natural product of the grape alone.

"The analyses upon which the above results have been based will be found fully recorded in the number of *Food, Water, and Air* for March, 1874."

THE SIAMESE TWINS.

THE *Philadelphia Medical Times* contained an account of the last illness and death of the Siamese Twins, and also a Report made to the Philadelphia College of Physicians by Dr. Pancoast and Dr. Allen, of the results of the *post mortem* examination which determined the exact nature of the connecting band.

It will be remembered by those who saw the twins during their late visit to this country, that Chang, the left-hand brother, was smaller and more feeble than Eng. These names are said to be the Siamese words for "left" and "right" respectively. Chang, moreover, had of late years become a drunkard, and suffered under the infirmity of a morose and irritable temper. Notwithstanding that Eng is said to have been of an amiable disposition, quarrels between the brothers were very frequent, and sometimes led to blows. On one occasion a quarrel led to

an appearance before a magistrate, and the question of separation was then seriously discussed, Eng saying that Chang was so bad that he could not remain connected with him.

For many years they lived with their wives and families in the same house; but for some time past they had separate establishments, about a mile and a half apart; and they came to an agreement that each, in rotation, should be master of the other's movements for a period of three days. On Thursday, January 15, 1874, Chang's three days of dictatorship expired, and although he was at the time suffering from cough and difficulty of breathing, and had been advised by Dr. Hollingsworth, his medical attendant, not to go out, the brothers departed as usual to Eng's house in order to spend his three days there. They made the journey in an open waggon during intensely cold weather. On the following morning Chang declared himself better, but said that in the night he had suffered from increased pain in the chest, with so much distress that he thought he should have died. On that (Friday) night, after retiring to rest, the twins got up and sat by the fire, Chang declaring that he could not breathe while lying down. After a time they went to bed again, and when attention was called to them on Saturday morning, January 17, Eng woke up from sleep to find Chang already dead and cold. Eng became greatly alarmed and agitated, and, after an hour or two of extreme distress, passed into a state of stupor, in which he shortly breathed his last. Both were dead before Dr. Hollingsworth arrived.

There seems to have been no assignable cause, other than alarm or shock, why Eng should so soon have followed his brother. He was in good health, and the slight community of circulation that has been shown to exist between the two left them quite independent of each other in all vital relations. When Chang was intoxicated, Eng was in no way affected, and he had no participation in Chang's maladies. On their return voyage from Europe three years ago, Chang had a paralytic stroke, from which he had only partially recovered, but Eng had no share either in the illness or in the improvement. Chang having been found cold, it is plain that Eng must have slept soundly for some time after his brother's death, and that it was only his knowledge of the event which produced any evil consequences.

When the twins were in England a very careful examination of the band, with a view to the possibility of severance, was made by Sir William Fergusson and other surgeons. It was manifest that, in the upper part of the band, the terminal cartilages of the two breast bones were firmly united; and below this cartilaginous union it seemed probable that there was a direct communication between the two abdominal cavities, as, when either twin coughed, the impulse was carried over beyond the middle line. On this ground mainly, and also on account of the age and general health of the twins, it was felt that an operation

for separating them would involve risks which it seemed hardly justifiable to incur.

As soon as the intelligence of the death reached Philadelphia, a meeting of some of the leading medical men of the city was convened, and Drs. Pancoast and Allen were deputed to go to the residence of the late twins and to endeavour to obtain permission to make a *post mortem* examination. After some difficulty they carried their point, and were even allowed to bring the bodies to Philadelphia to be embalmed there; but they were placed under restrictions, with regard to the situation and extent of their incisions, which rendered their task one of considerable difficulty. Notwithstanding this, they seem to have determined nearly all the questions which could be raised upon any point of actual structure.

Beneath its skin and subcutaneous fat the band was found to contain, at its upper part, as had been made out during life, a close junction of the cartilaginous terminations of the two breast bones, with complete continuity of their substance. At its lower part it contained three closed pouches or diverticula, comparable to glove-fingers. Of these the upper and lower were continuous with the abdominal cavity of Chang, and passed across the band to terminate in closed rounded extremities on the side nearest to Eng. The third pouch was continuous with the abdominal cavity of Eng, and passed across the band to terminate in a closed extremity on the side nearest to Chang. There was thus no communication between the two abdominal cavities, and there was a simple explanation of the conveyance of the cough impulse which had caused the existence of such a communication to be surmised. From each body the liver projected somewhat into the band, below the cartilage and above or between the abdominal pouches; and the two livers were united by a portion of connective tissue, carrying small blood-vessels. This, besides the skin continuity and the junction of the cartilages, seems to have been the only direct union between the two, and to have been small and unimportant in its character; but Drs. Pancoast and Allen surmise that it was originally an absolute continuity of liver tissue, which has since undergone contraction and alteration. At the time when the Report was presented, the viscera of the chest and abdomen in the two bodies had not been examined; but no alteration in their ordinary position and relations was anticipated.

THE END.

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